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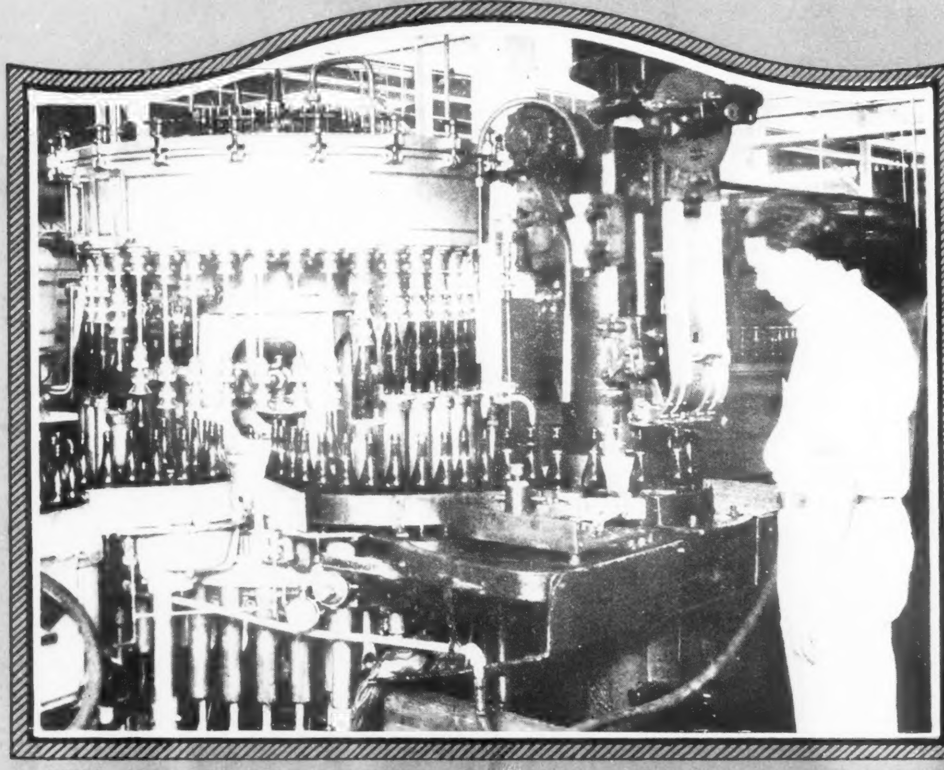

THIS AIR-OPERATED MACHINE IN A GINGER-ALE PLANT PUTS RIGHT AMOUNT OF SYRUP AND EXTRACT IN EIGHTY BOTTLES EVERY MINUTE

Big Hydro-Electric Project in the South
C. H. Vivian

How Rock-Drill Steel is Made in Sweden
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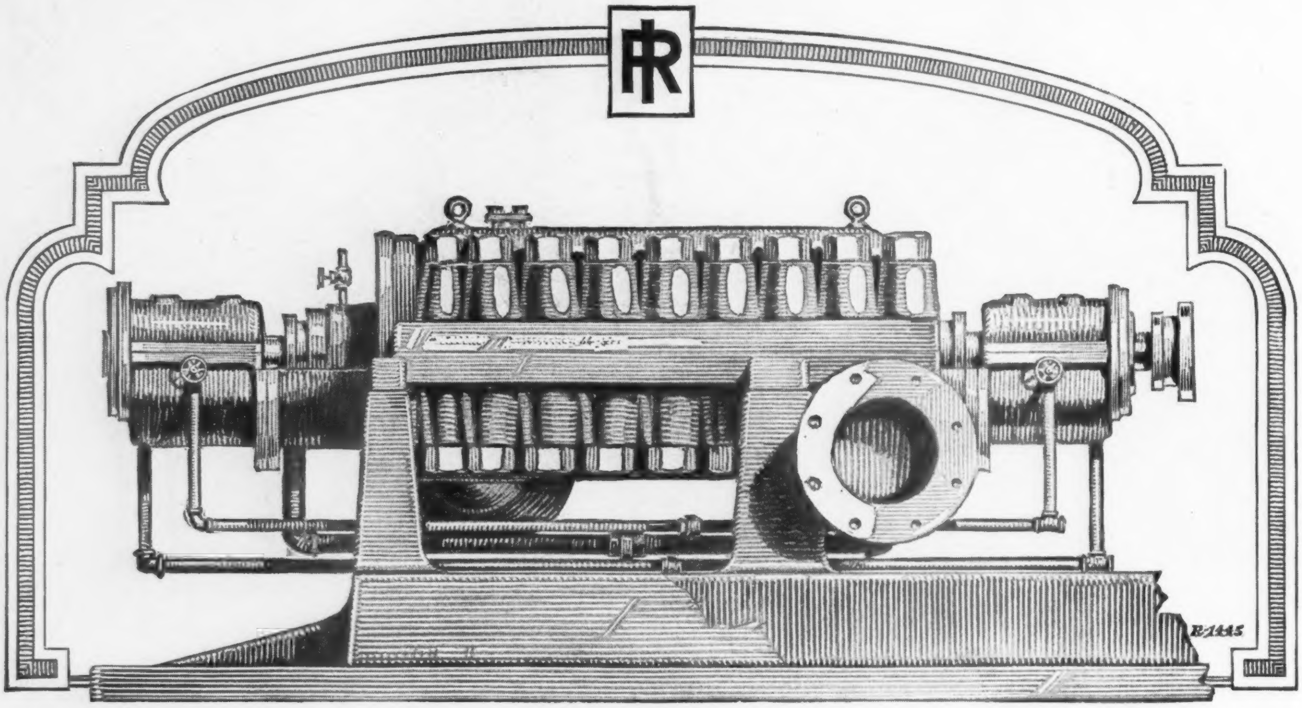

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The casing will be of cast steel.

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Cameron Pumps

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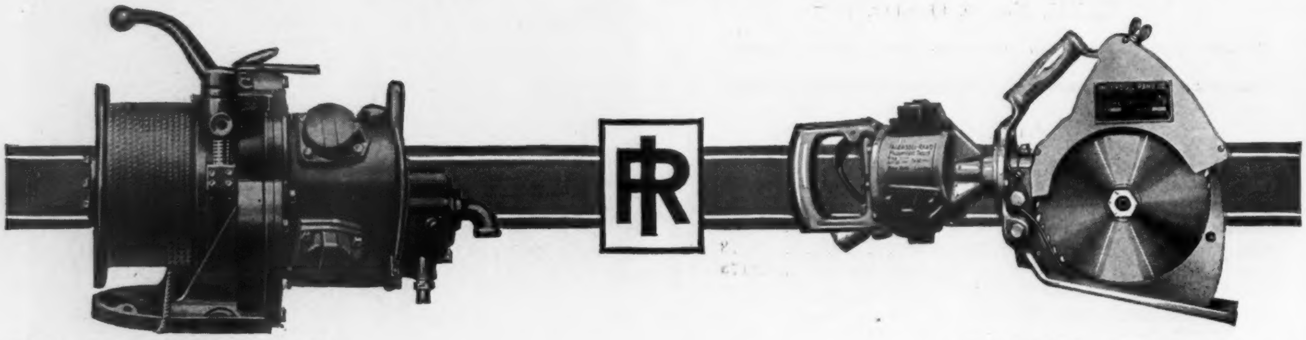
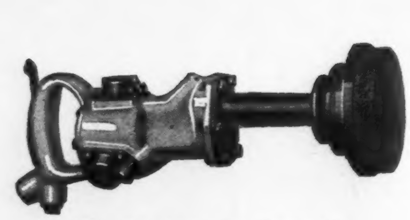


Utility Hoist—speeds up hoisting and handling operations.

Safety-First Air Saw—does more work than 5 to 10 men with hand saws.



No. 6G Concrete Surfacing Machine.

No. 57 Clay Digger—has 50 per cent more power than any other tool of equal weight.

No. 33 Backfill Tamper—the most powerful lightweight rammer available.

No. 157 Trench Digger—a digging tool with 50 per cent more power.

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4. The No. 57 Clay Digger has 50 per cent more power for its weight than any similar tool yet available. With this new tool, the operator can do additional work with no more fatigue.

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OCTOBER, 1927

Big Hydro-Electric Project in the South

Part of Tallassee Power Company's Plan to Develop Ultimately 250,000 Horsepower

PART I

By C. H. VIVIAN

RECENT years have brought a notable increase in the industrial activity of the South. One of the principal contributing factors to this new era has been the development of natural power resources. Streams that were allowed for ages to flow unmolested to the sea are now being harnessed to turbines that transform their latent energy into electrical force.

In the construction of these power plants and their related works, compressed air is an all-important agency. In addition to operating the rock drills that drive tunnels and excavate for dam footings, for powerhouses, and for other structures, compressed air performs manifold other services. The Tallassee Power Company is now completing a sizable hydro-electric undertaking in North Carolina. This article is devoted to a description of the construction methods—particular attention being given to the part played by compressed air.

THE Tennessee River has long been recognized as a potential power source of great magnitude and, in recent years, considerable developmental work has been done in putting some of its energy to use. The Little Tennessee, which joins the parent stream a few miles below Knoxville, is made up of numerous tributaries which, for the most part, rise in the Great Smoky Mountains. Chief among these streams is the Cheoah River. Conditions along the Little Tennessee system are highly favorable to power generation; and there the Tallassee Power Company has entered upon a construction program that will eventually make available some 250,000 hp. of electricity.

The first of these hydro-electric plants has been in service for several years. It is situated at Tapoco, N. C., on the Little Tennessee—roughly 55 miles southeast of Knoxville by railroad. It includes a concrete arch dam with adjacent penstocks to carry the impounded water to turbines, which drive four generators of 17,500-kw. capacity each, or a total maximum output of 70,000 kw. The Cheoah flows into the Little Tennessee just below the Tapoco plant. Ten miles above this confluence, the second unit of the proposed series of generating stations is now nearing completion on the Cheoah. This plant not only will harness some of the Cheoah's power but will divert the waters, after use, to the Little Tennessee, thereby increasing the service of the Tapoco powerhouse.

The present development at Santeetlah, N. C., consists of a concrete dam of approximately 5 miles of tunnel and steel-pipe conduit, of a 50,000-kw. generating station, and of a transmission line. It is scheduled for completion by January 1, 1928, although ground was not broken until early in 1926. The undertaking calls for an expenditure of about $8,000,000, not including the cost of constructing 10 miles of standard-gage railroad from Tapoco to Santeetlah for the transportation of workers and supplies.

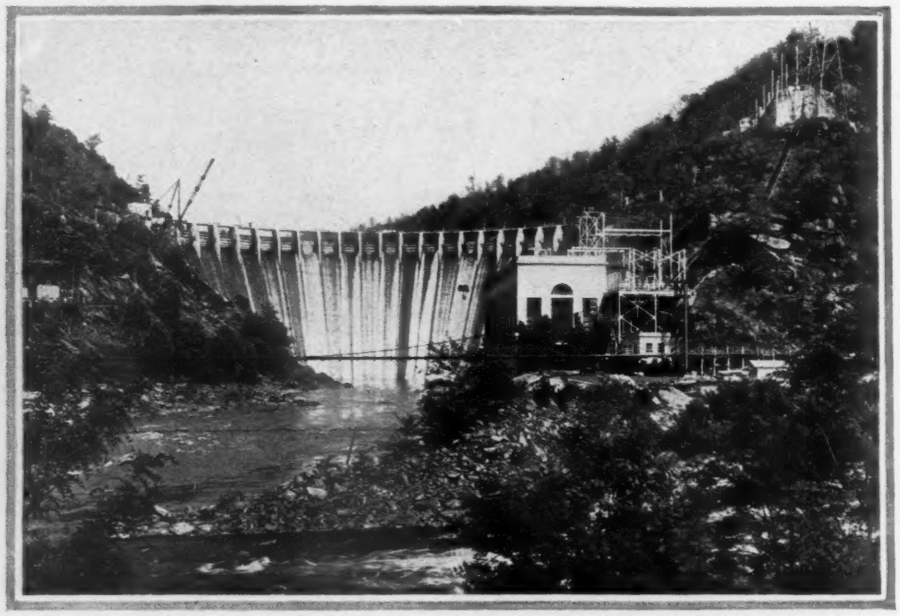
The general plan of the development is indicated by accompanying diagrams. The topography of the region is such that five short tunnels, rather than one long one, are required. These range in length from 400 feet to 9,100 feet, and total 19,600 feet. They will be connected by riveted steel pipe which will take the form of inverted syphons at two points where the pipe crosses the Cheoah River.

The spillways of the dam will be at an elevation of 1,805 feet. The center of the outlet conduit will have an elevation of 1,730 feet, thus providing a draw-down of 75 feet from the high-water line. In its passage from the dam to the base of the 188-foot surge tank, at the top of the penstocks, the water will fall 62 feet. There will be a further fall of 524 feet in the penstocks—the tailrace being at an elevation of 1,154 feet and at the high-water level of the Tapoco Dam Reservoir. The operating head available will thus be between 576 and 651 feet, according to the height of the water behind Santeetlah Dam.

For construction purposes, the various parts of the project were divided into several, though coördinated, undertakings. The Tallassee Power Company decided to build the dam and the powerhouse and to do certain other work through its own construction department. The driving of the tunnels, the fabrication of the steel pipe line, and the erection of the penstocks were let under separate contracts and were awarded to specialists in those respective lines.

Compressed air is one of the principal motive forces being employed on the job. It operates the whistle which calls the workers at the Santeetlah camp from their beds at 4:30 every morning, and which gives the signal for the laying down of tools at night. During the hours that elapse between these two blasts, compressed air finds use at one point or another every minute of the day. There is no part of the undertaking to which it does not contribute, and many of the operations depend primarily upon it.

As the water will run, it is but 5 miles from



The concrete arch dam and the powerhouse at Tapoco, N. C., viewed from the confluence of the Little Tennessee and the Cheoah rivers.

Santeetlah Dam to the power house at Rymer's Ferry. Overland, however, it is some 9-miles; and for a considerable stretch of that distance the only direct means of connection between the intermediate points of the work is a foot trail. This rises to its maximum height at Yellow Mountain, 2,867 feet above sea level. The Tallassee Power Company's railroad serves the dam and the upper sections of the pipe line and the tunnels. Supplies for the power-house and adjacent activities are taken in by railroad to Tapoco and thence 5 miles by boat to Rymer's Ferry. Operating bases situated between the railroad and the waterway receive their materials over roughly constructed roads. The first machinery taken into the more isolated regions was literally dragged over the hills.

To minimize confusion in describing the manner in which the work is being carried on, it is desirable to consider one feature at a time. The dam will be taken up first. As was stated before, approximately 10 miles of standard-gage railroad was built as a preliminary operation. This line follows the canyon of the Cheoah River, and is a continuation of the railroad from Calderwood, Tenn., to Tapoco, N. C., constructed at the time the Tapoco Dam was reared. Calderwood is 47 miles from Knoxville, on the Southern Railroad. The extension of this mountain rail link involved the continual use of compressed air for drilling, as thousands of cubic yards of rock had to be blasted out to make room for the right of way in the rather narrow canyon.

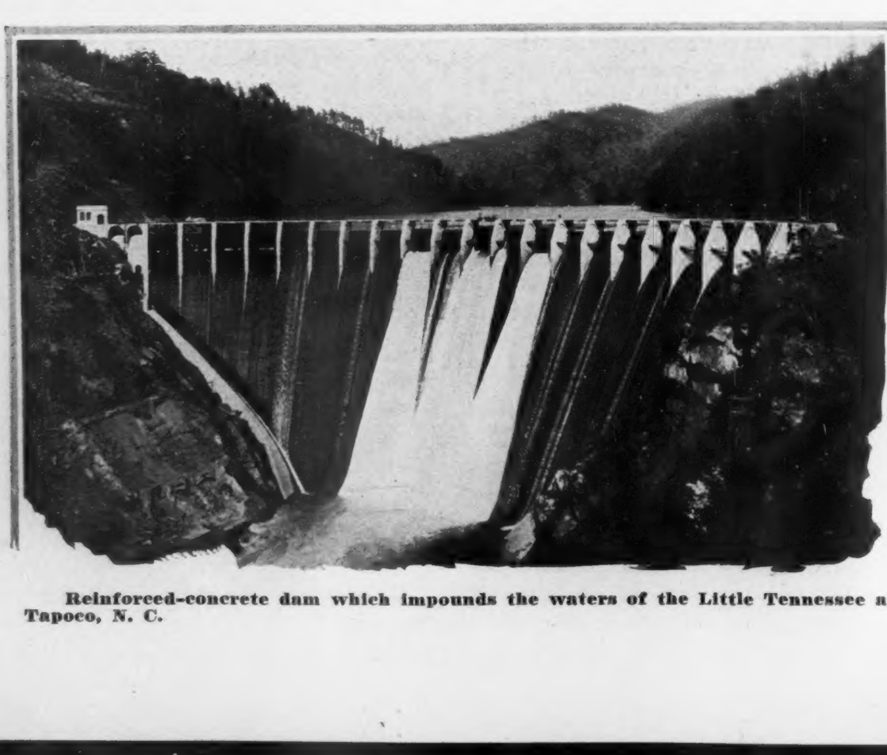
The Tallassee Power Company operates both the railroad from Calderwood to Santeetlah and the boat service from Tapoco to Rymer's Ferry to distribute supplies to the various points of use and to provide the workers with a convenient means of visiting the outside world from time to time. A combination freight-and-passenger train makes a round trip daily; and the workmen are transported free of charge. A Shay geared engine is employed to haul the cars because of the high grades existing at some places.

The general headquarters of the Tallassee Power Company on this development are at Santeetlah. Because of this, and also because the dam is one of the principal parts of the work, a large camp was needed there. The building of this camp was started on January 15, 1926; and within a few weeks the necessary facilities were available to begin construction. This camp has substantial and comfortable living quarters, consisting of bunk houses and numerous small cottages, that accommodate 500 persons. There are two mess halls—one for white employees and one for negroes, who constitute a considerable portion of the labor force not only at the dam but elsewhere on the project. There are also completely equipped blacksmith and carpenter shops, as well as a concrete plant of considerable size.

Careful attention is given to camp sanitation. Two tanks, at an elevation of 1,900 feet, furnish water throughout the camp. The water is pumped from the river; but before it passes into the tanks it is first filtered and chlorinated. An electrically driven pump is installed for this service. In case of breakdowns, there is a reserve unit, a Cameron 16x10x18-inch pump that can be operated by either steam or compressed air. Shower baths are provided in some of the camp buildings; and all structures are equipped with electric lights. To serve the camp and the scenes of operations with electric power, a 66,000-volt transmission line was run on wooden poles from the Tapoco power plant and an 1,800-kw. substation was erected near the camp. Some of the numerous motors utilize 2,200-volt current and some 440-volt current, while the lighting and certain other circuits use current of 220 and 110 volts, respectively.

The dam is of a type which, though not unique, is rather infrequently employed. It consists of a constant-radius-arch center section, flanked on either side by a gravity spillway section and a nonoverflow gravity section. In effect, the arch segment is supported by massive abutments which, in their turn, are flanked by the overflow sections. Each of these will be fitted with four Taintor gates of 10x25 feet. At either side of the overflow sections are further gravity sections extending into the sidewalls of the canyon.

The arch abutments provide adequate anchorages for the arch section and permit the saving of a considerable yardage of concrete over that which would be required for a gravity structure, throughout. The total length of the dam at the crest will be approximately 1,127 feet, and of this the central arch makes up 266 feet. The arch section is 48 feet thick at its base. The center of the arch is battered on the upstream side and is perpendicular on the downstream side. On either side of the center there is a gradual transition to a downstream battered face and to an upstream perpendicular face. This is the plan for all sections other than the arch section. The nonoverflow sec-



Reinforced-concrete dam which impounds the waters of the Little Tennessee at Tapoco, N. C.

1—Looking down the twin penstocks toward the powerhouse situated at Rymer's Ferry on the Little Tennessee.
2—The powerhouse, and the penstocks that deliver water to it from the Santeetlah Reservoir 5 miles away.
3—This view of the Santeetlah Dam shows the difference in thickness between the central arch and the gravity sections at either side.
4—Close-up of one of the gravity sections. Concrete is carried to the dam on flat cars on which are placed the buckets which, when loaded, weigh 5 tons each.
5—How the Santeetlah Dam looked when approximately two-thirds finished. The method of constructing the dam in blocks is shown. At the left may be seen the steel pipe line that will carry water to the first tunnel section.

tions have a maximum basal thickness of 120 feet 6 inches. This dimension applies also to the spillway sections, which, besides, have aprons on the downstream side that extend 60 feet farther out from their bases. The general width of the dam at the crest is 10 feet, except at the extreme side sections where it is 5 feet. At the center, the crest of the structure will be 189.5 feet above the surface of the stream as it existed prior to the beginning of work. The reservoir to be created will have an area of approximately 3,000 acres at high water.

Cofferdams were built alternately at either side of the river basin during the excavating for the dam footings. The site selected revealed solid, compact rock practically at the ground surface so that comparatively little material had to be removed to secure the desired foothold for the foundation. The excavating was done with compressed-air drills.

The dam calls for the placing of 195,000 cubic yards of concrete. The construction plan adopted is such that the structure is divided into blocks or sections each having a face dimension of from 40 to 50 feet. Five-foot vertical sections of these blocks are poured at a time; and each section is allowed to stand at least 30 days for setting and contraction before an adjacent block is poured. By this method some parts of the dam are carried to their designed height while adjoining sections have progressed only a few feet above the ground level.

Picturesque parts of the Cheoah River whose tumbling waters will be impounded to develop power.

To allow for the passage of the stream through the structure while building, two diversion tunnels, each 13x20 feet, were left open. A circular opening, approximately 18 inches in diameter, was allowed to remain unconcreted in each section surmounting these tunnels—constituting, in effect, pipes leading downward into the tunnels. When the dam is completed, the diversion tunnels will be sealed at both ends and will then be filled with concrete through the overhead openings. Compressed air will be used to obtain the pressure necessary to insure the complete filling of these tunnels. Besides, openings have also been left at suitable places for the introduction of grout into the tunnels.

Arrangements were likewise made for grouting the rock beneath the dam to effectually seal it against ground water that might otherwise undermine and weaken the structure. Four feet from the upstream face of the dam, on ground where the structure was to rise, a row of holes was drilled to a depth of 28 feet. These holes were spaced 10 feet apart. One end of a 2-inch pipe was connected with each of these holes and the other end was left exposed on the upstream face of the dam after the pouring of the concrete. When the general dam structure had progressed to a height of 50 feet, grout was introduced through these pipes—the grout being composed of neat cement and water. A standard pneumatic grouting machine was employed for this work.

In addition to these grout holes, others were drilled later at a distance of approximately 2 feet from the upstream face of the dam and outside the building lines. They were staggered with respect to the first line of holes; but otherwise they were the same in character and also were used for grouting the underlying rock. A third row of holes was drilled on a line 17½ feet from the upstream face of the dam but within the foundation lines. These will serve to reveal any water that may penetrate the rock structure beneath the back portion of the dam. These holes open into the inspection galleries in the dam and can be drained. The placing of the three lines of holes entailed a total drilling footage of 4,500 feet. The drilling was done with "Jackhamers" and tripod-mounted sinking drills.

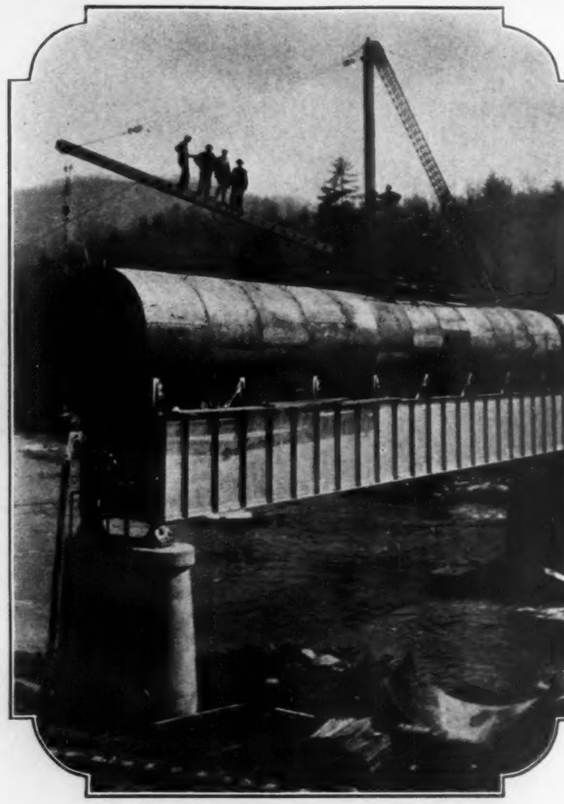
The concrete plant is situated about 250 yards below the dam site; and the material is handled in 2-cubic-yard bottom-dump buckets. These are transported to and from the mixing plant on flat cars drawn by steam engines of

1—Drilling on a bench in the quarry that furnishes rock for the Santeetlah project.
2—Crushing plant that is able to turn out daily 600 cubic yards of coarse and fine aggregates for the concrete used on the Santeetlah project.
3—This air-operated hammer performs many useful services in the blacksmith shop of the Tallassee Power Company at Santeetlah.
4—This large electric shovel loads rock into cars at the Santeetlah quarry.
5—Close-up of the quarry showing "Jackhamers" block-holing large pieces of rock.

the rod type. Eight of these locomotives —four of 21-ton size and four of 40-ton size—are employed on various parts of the work.

The trackage, of which there is a total of three miles in the Santeetlah camp yards, extends along both sides of the river up to the dam site. At the different points of delivery, the loaded buckets —each weighing five tons—are raised by derricks into position for dumping the concrete into the forms. As a section or block progresses in height, two or even three derricks are successively employed to elevate the concrete. Eleven steel derricks are installed for this work, and at various times all have been in use. Some are driven with compressed air and others with steam. Compressed air is utilized for cleaning around the forms, for chipping, and for various other purposes about the dam.

The pouring of concrete was started in August, 1926. The average monthly pour for the first ten months was slightly over 14,000 cubic yards; and at the expiration of that time the crews were approximately fifteen days ahead of the schedule laid down for them. The record month during the first ten months was April of this year, when 19,372 cubic yards were placed.


Close-up showing the assembling of the 11-foot steel pipe which crosses the Cheoah River and connects tunnel sections of the Santeetlah project.

The concrete plant has a normal maximum capacity of 800 cubic yards per 10-hour day. Two 2-cubic-yard Smith mixers are used, and a third is provided for stand-by service. The plant is of interest as it is completely equipped for crushing rock to various sizes, and produces all the sand that enters into the concrete. The rock is quarried four miles below Santeetlah, and is delivered in trains of 20-cubic-yard Koppel steel cars to the mixers. There it is dumped into a Gates No. 21 gyratory crusher driven by a 500-hp. motor. This crusher produces the coarse aggregate, for which rock up to six inches in greatest dimensions is suitable.

The process of making sand requires considerable handling of materials and the use of great quantities of electric power. After the initial breaking up in the No. 21 crusher, the rock designed for this purpose passes through Gates No. 6 gyratory crushers and then through 6-inch Allis-Chalmers gyratory crushers, where it is reduced to ¾-inch size. It next goes through Anaconda 54x24-inch crushing rolls and, finally, through XX 54x24-inch crushing rolls. After screening, it is elevated to bins. At different stages throughout the crushing operations provision is made for the rejection of dust and other undesirable materials. The crushing and mixing plant is powered throughout by motors with an aggregate capacity of 1,500 hp.

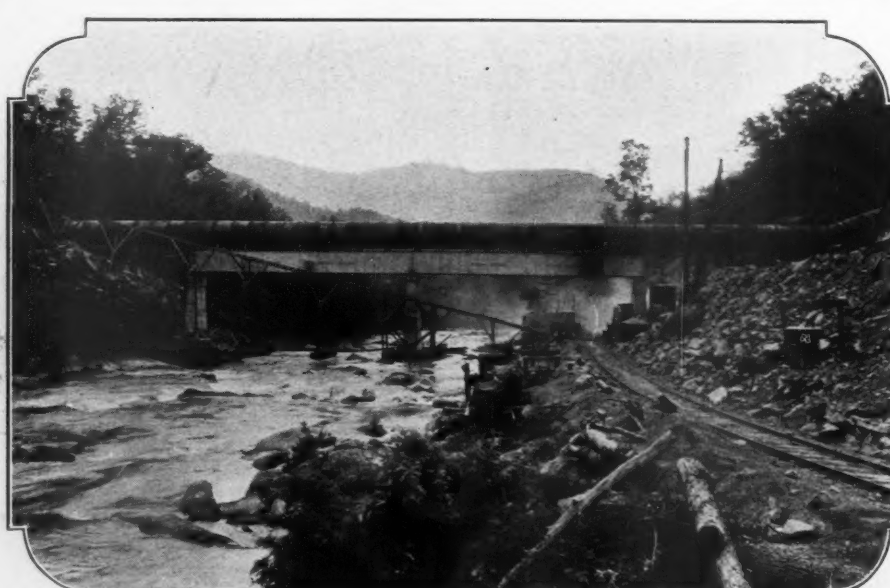
A normal day's mix requires five carloads of cement. The sacks are unloaded directly on to a conveyor belt, which is arranged so as to carry them either to the mixing plant or to storage piles, as desired. In preparing the charges for the mixer, extreme care is exercised in measuring the water—this being an important factor in determining the strength of the concrete. The mixer is served by a separate water-supply system.

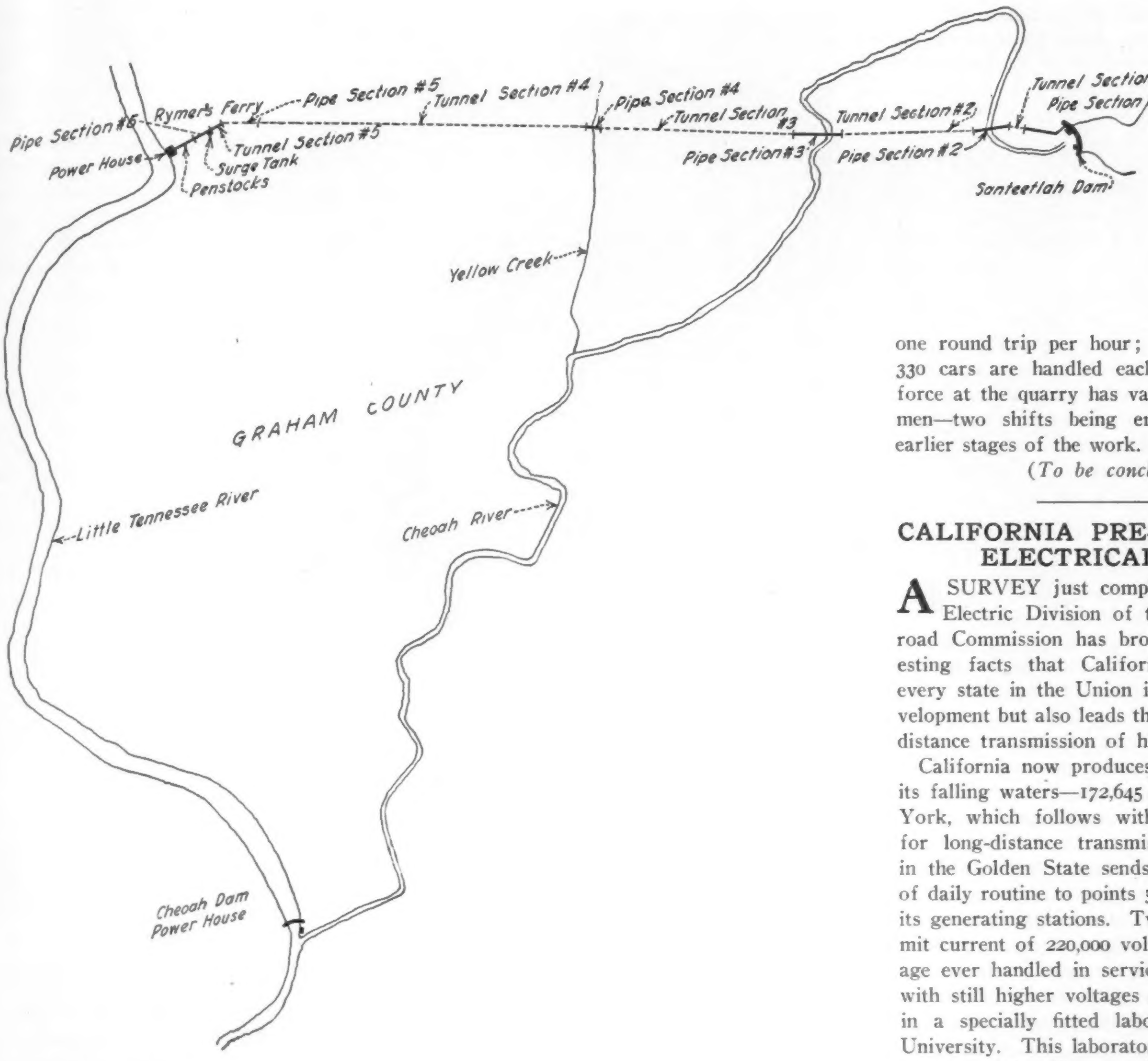
A concrete-testing department is maintained, with an experienced technician in charge. Daily tests are made of the concrete for the dam, as well as of that employed elsewhere. Samples are taken at the dam from each 5-foot lift. Test cylinders are broken after 7, 28, and 90 days. The specifications for the arch section of the dam call for concrete which will resist a pressure of 2,500 pounds to the square inch after 30 days, while that for other parts of the dam must have a minimum crushing strength of 2,000 pounds to the square inch after 30 days.

The quarry is an important and a busy place. During the first ten months of concrete work on the dam—at the end of which period the structure was 73 per cent. completed—300,000 cubic yards of rock were quarried. A compressor plant having a capacity of approximately 2,400 cubic feet per minute furnishes the air at the quarry. Something over 1,000 feet of this is supplied by an Ingersoll-Rand Type XB machine which saw duty during the building of the railroad and during the construction work on the Tapoco Dam. The quarry equipment also includes a 10x7x13-inch air-driven Cameron pump which supplies circulating water for the compressors, and water for the blacksmith shop and for a steam shovel.

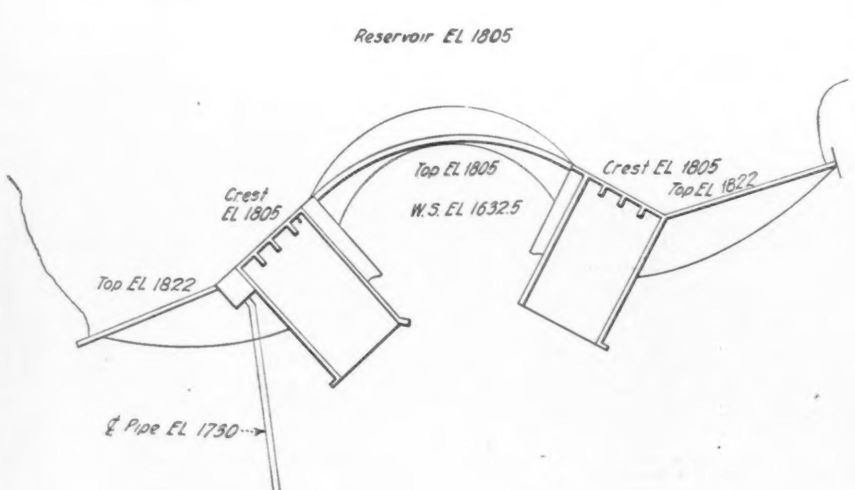
All drilling at the quarry is in the nature of down holes. Sinking drills of the N-72 type and DCR-23 "Jackhamers" have given good service there. Eighteen-foot holes are drilled. The average run per piece of steel is 2 feet; and the drilling has averaged 1½ linear feet for each cubic yard of rock brought down. Forty per cent. dynamite is used in blasting—the powder consumption averaging 1.425 pounds per cubic yard of rock broken.

After being shot down, the rock is loaded into cars by two Bucyrus shovels, one powered by electricity and the other by steam. Seven cars of rock, each with a capacity of 14 cubic yards, are hauled at a time—Shay geared engines being employed to negotiate the stiff grades between the quarry and the concrete plant at Santeetlah. The normal schedule is


Where the 11-foot pipe line is carried across the Cheoah River. Note method of supporting the conduit on a box-girder bridge.



Sketch showing how waters of the Cheoah River will be impounded at Santeetlah; carried through 5 miles of tunnels and pipe line to the turbines at Rymer's Ferry; and then made available for further use at the Tapoco powerhouse on the Little Tennessee River.



General plan of the concrete dam at Santeetlah, showing the relation of the constant arch section to the gravity sections at either side.

one round trip per hour; and an average of 330 cars are handled each week. The labor force at the quarry has varied from 85 to 125 men—two shifts being employed during the earlier stages of the work.

(*To be concluded*)

CALIFORNIA PRE-EMINENT IN ELECTRICAL FIELD

A SURVEY just completed by the Gas & Electric Division of the California Railroad Commission has brought out the interesting facts that California not only leads every state in the Union in hydro-electric development but also leads the world in the long-distance transmission of high voltages.

California now produces 1,930,000 hp. from its falling waters—172,645 hp. more than New York, which follows with 1,757,355 hp. As for long-distance transmission, one company in the Golden State sends power as a matter of daily routine to points 500 miles away from its generating stations. Two companies transmit current of 220,000 volts—the highest voltage ever handled in service; and experiments with still higher voltages are being conducted in a specially fitted laboratory at Stanford University. This laboratory, which was erected at considerable cost, is equipped to work with voltages as great as 2,000,000 in an effort to solve the problems involved in the transmission of current exceeding 220,000 volts.

FREEZING FLAMES TO CHECK THEIR SPREAD

A NEW type of fire extinguisher that puts out flames by freezing them, was demonstrated not long ago in the British plant of the General Electric Company. The extinguisher—a steel cylinder fitted with a short piece of hose having a funnel-shaped nozzle—is filled with liquid carbon dioxide under a pressure of about 1,000 pounds per square inch.

According to the report of the test: "The release of the gas to the atmosphere"—which is effected by the turn of a hand valve—"so chills the gas that part of it solidifies, forming an intensely cold 'snow.' The 'snow,' instead of melting like ordinary snow, changes indirectly from a solid form into a gas. This vaporization process absorbs heat in great quantities from the burning materials; and when the temperature is sufficiently lowered the fire ceases to burn."

MODEL OF MT. LASSEN A SHOW FEATURE

DURING California's First Annual Sportsmen's Show & Outdoor Exposition, held not long ago on the Marina in San Francisco, the dominant feature was a huge replica of Mt. Lassen, that great snow-clad peak in the northern part of California that reaches an altitude of 10,570 feet and that has the distinction of being the only active volcano in the United States.

In this connection, it might be of interest to mention that there has been much speculation as to the probable cause of Mt. Lassen's intermittent outbursts that are unlike the eruptions of other volcanoes that spit forth smoke, fire, and lava. Mt. Lassen's eruptions are of a decidedly explosive character; and one highly plausible explanation therefor has been advanced that is endorsed by many scientists. The theory is that rock pressures, due to crustal movements at the site of Mt. Lassen, lead from time to time to the development of high temperatures. This heat is sufficient to extend to the surface and to cause snow upon the mountain to melt and to send into the fissures of the underlying rock considerable volumes of water. This water is trapped in pockets, and steam is produced having sufficient explosive pressure to disrupt the overlying mass and to shatter it violently. It is noteworthy that steam has frequently been observed issuing from the crater for a while after an eruption.

Compared with its prototype, the replica was small even though its crest rose to a height of 54 feet and its base had a maximum length of 300 feet. Whether or not it was built to scale, it has been said that the contours of this "miniature" Mt. Lassen were so true and that it was so realistic in general appearance that it could scarcely be distinguished from the original when viewed from afar. Be this as it may, much of the natural effect obtained was attributed to the use of air-operated paint sprays in the hands of skillful operators who gave the expansive surfaces the semblance of snow, rocks, vegetation, etc. The whole scene was given an added touch of beauty by a cascade of water that tumbled down the mountainside into an artificial lake at the foot of the slope.

In coloring the surfaces of the model of Mt. Lassen the paint was applied with pneumatic sprayers.

LOOKING FOR A DOMESTIC SOURCE OF MANGANESE

THE United States, which is by far the largest producer of iron and steel, is now almost wholly dependent on foreign supplies of manganese, which is so essential to the industry. In 1925, the latest statistics available, we absorbed approximately 35 per cent. of the world's output of high-grade manganese ores, and of this only 4 per cent. came from domestic sources. But the hope is held out by the United States Geological Survey that this situation may be altered for the better and that our manganese deposits may be made to yield a greater percentage of the needs of our iron and steel industry.

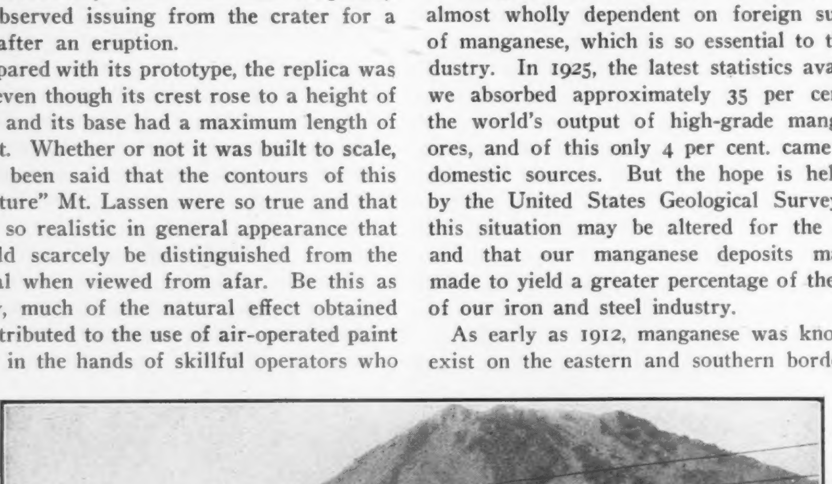
As early as 1912, manganese was known to exist on the eastern and southern borders of the Olympic Mountains, in the State of Washington. Subsequent attempts to work the deposits were not successful because the ores then found contained too much silica to permit their conversion into alloys of acceptable grade. Prospecting carried on since the World War along the north and the southwest slopes of the mountains has led to the discovery of other deposits of which one, near Lake Crescent, has produced in three years about 17,000 tons of ore containing more than 52 per cent. of manganese and less than 9 per cent. of silica. This is probably the largest concentrated body of ore of that grade so far located anywhere in the United States.

Preliminary studies made by geologists of the Geological Survey indicate that while the composition of the mineral may vary from place to place, still all the beds lie at nearly the same stratigraphic position in the rock section—thus leading to the belief that other deposits of high-grade ore will be found in the same belt that may yet help to make us independent of foreign sources of supply.

GAS FOR COOKING SOLD BY TANKFUL

THE housewife need no longer despair even though her home be beyond the reach of public-service gas mains. Still, she can get along without the old-fashioned stove that is associated with dust and ashes and uncomfortable heat in the summer months. The long and the short of it is that a new fuel can now be delivered at her door in tanks, in which it is stored under pressure.

This gas, for such it is, is a product of natural gas, and is distributed by one of the largest industrial organizations in the country. Its use calls for no complicated equipment. The container, itself, which holds 5,000 cubic feet of gas, is stored in a neat enameled steel cabinet that is kept outdoors on a concrete base and within easy reach of a modern gas range in the kitchen. A standard gas pipe carries the fuel to the burners; and the flow of the gas is regulated by suitable control mechanisms. When one container has been emptied another is substituted in its stead—a renewal service man making the exchange without entering the house.



The model of Mt. Lassen that attracted much admiring attention.

Walking on haulage roads in mines is always a dangerous practice, but the danger is increased when a door is encountered that blocks the line of vision. To safeguard its workers, a mine in Alabama has had an air-lock manway built alongside a much-used door on its main haulway. This passage is about 18 feet wide, with doors at either end, and is in line with the footpath adjacent to the track. To minimize the fire hazard, the walls of the tunnel are made of concrete.

Compressed Air in the Wrecking Business

By M. G. RAHLFS

ONE of the most interesting things in connection with the physical growth of large cities is the enhancement of realty values. It is the more interesting because it is speculative. So many factors are involved and they are so largely intangible that even the keenest students of the subject are liable to err in their efforts to predict which areas in any municipality will be most desirable for business purposes a decade hence.

Floor beams and other steel in the balcony were cut with oxyacetylene torches before the walls were razed.

Broadly speaking, the erection on a site of a more impressive structure than the one that has stood there previously usually acts as a magnet for other building enterprises; and there arises a district which, temporarily, at least, attains a popularity that brings with it a pronounced increment in sales values. In this way is often reared a group of structures that are so superior in appearance as to render some of the earlier buildings in the zone comparatively antiquated and out of keeping with their new neighbors.

As a result, it becomes a matter of practical utility to remove the older structures, and momentarily to sacrifice the money they represent in order to make room for higher, more modern, and more imposing piles of masonry and steel. In such an instance, the demolition of the existing building becomes, paradoxically, an integral part of the construction operations.

Where the land concerned is high priced and the prospective rents from the new structure are sizable, any delay in the completion of the building obviously becomes expensive. For this reason, it is desirable that the greatest possible speed be exercised in removing the old building to clear the site for the beginning of work on the new one. At the same time, it is commonly recognized that care should be taken to assure the maximum salvage of the materials involved.

Compressed air has come to be looked upon as one of the most dependable agencies in house wrecking. Air-operated tools permit effective work to be done with dispatch, and fit in well with plans designed to reduce structures by easy stages so as to permit the conservation of a large part of the masonry, etc.

A case in point is that of the Majest'c Theater, in Buffalo, which was built in October, 1912, and was at that time considered one of the best-constructed buildings in that city. The march of progress decreed, however, that it should be torn down this year to make way for an office structure. The contract for salvaging the materials was let to the Buffalo House-wrecking & Salvage Company, which concern, in turn, contracted with the Gleasner Compressed Air Supply & Equipment Company, of Buffalo, to handle the demolition work.

Operations were started by breaking the reinforced-concrete floors down to the basement and by freeing the steelwork of concrete. The floor beams and the steel framework of the balcony were then cut by means of acetylene torches, and that material was salvaged before the wrecking of the walls was begun. At the same time, bricks and concrete were removed from around steel pillars, and rivets were cut out. The result was that the walls were left standing like a shell—creating a clear space into which they might be toppled.

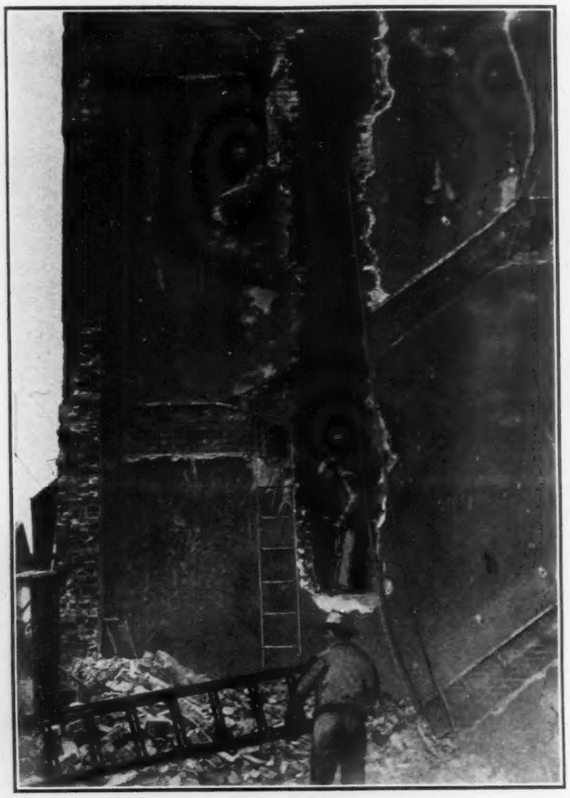
The walls were composed of bricks, laid in Portland cement. The main walls were 30 inches thick at the bottom and 20 inches at the top, while the fire walls around the stage were 36 inches thick The plan for taking down the main auditorium walls was to divide

Left—How the theater building looked at one stage of demolition.
Right—Close-up taken just when a large section of masonry wall was dynamited.

them into sections, and to raze a section at a time. The advantages of this were twofold: First, it was found that the sections could be made to fall flat upon their sides, and that the impact with the ground would separate the bricks from each other in fairly regular courses. This simplified the work of breakage as well as of salvage, as the men engaged in cleaning the bricks were able to remove them from the mass without recourse to picks or sledges. Second, the risk to the workmen was reduced to a minimum. An entire wall section was pulled at a time and when no workmen were in the building. Danger from falling bricks was thus averted.

The walls were cut into sections by making vertical slots or cuts from the top downward at suitable points. The tool selected for this work was the CA-35 paving breaker, of which seven were employed. When the slots had been finished, holes were then drilled into the base of each section with BAR-33 "Jackhamers," and into these charges of dynamite were placed. After the holes were loaded and a strain had been taken upon the section to insure its falling in the right direction, the charges of explosive were fired—thus weakening the base of the section enough to cause it to topple over. In addition to the air-driven tools mentioned, a DU utility hoist was employed about the work. Compressed air was supplied by two 9x8-inch Type 20 Ingersoll-Rand portable compressors.

The demolition was started on May 15 and was completed on July 2—the working time being extended approximately two weeks because of the salvaging of the steel in the floors and balcony. Fifteen men were employed on the job. A 10-story office building is now being erected on the site.



The walls of the main auditorium were razed in sections after vertical slots had been cut through the brickwork with I-R paving breakers.

Electric-power companies in the United States have attained such proportions that there are now 18 plants with an annual output of energy exceeding 1,000,000,000 kilowatt-hours annually. At the head is the Buffalo, Niagara & Eastern Power Corporation with a production in 1926 of 4,464,000,000 kilowatt-hours. No less than 126 of the power plants listed generate each year more than 100,000,000 kilowatt-hours.

NEW AIR-OPERATED SIGNAL

SOMETHING new in air signals for locomotives, motor and electric cars, signal towers, etc., has been devised by the American Strombos Company, Inc. These signals are operated with air at from 10 to 100 pounds pressure, which is regulated by the construction of the air inlet.

The inside of the signal consists of a bronze diaphragm which emits no sound but releases a succession of air waves that, by resonance, are so amplified in intensity as to penetrate or drown other noises. The signal horn can be attached to an air line and will not affect the air-brake system. It is functioned by means of the regulation lever valve and cord or by foot control. If remote push-button control is desired, a magnet valve is furnished. Many models of either curved or straight horns are made combining any number of projectors varying in length to meet different requirements.

ICE-CREAM INDUSTRY OF THE UNITED STATES

THAT ice cream continues to be one of the most popular "sweets" in America is brought out by the latest production figures compiled by the United States Department of Agriculture. Last year, a total of 324,665,000 gallons of ice cream was consumed—representing an increase in sixteen years of 240 per cent.

Even though the manufacture of ice cream is classed as a small branch of the dairy industry, using as it does but 3.8 per cent. of the country's milk yield, there are employed in that business more than 50,000 persons with an annual payroll in excess of $75,000,000.

NOVEL "PUSH-BUTTON" CORD

A NEW type of electric cord that also serves as a push button at any point throughout its length is becoming popular in Berlin where, according to *The Engineer*, it is being used in connection with electric bells and buzzers, and for starting and stopping machinery.

If the cable—which is the invention of a Hungarian engineer—is squeezed anywhere, the circuit is completed and the signaling or operating device is actuated. This is effected by having the wires woven into a loose braid and separated by an elastic non-conductor which, however, makes contact when pressure is applied. It can be readily conceived that such an arrangement could be utilized to advantage in a number of directions. For instance, by laying such a cord under a carpet, an unwary burglar might be made to sound the alarm set to trap him.

Tumbling a long section of side wall. This was done with charges of dynamite placed in a line of horizontal holes drilled with BAR-33 "Jackhamers."

It has been officially stated that the forest industries of Canada represent an investment of $666,000,000.

Many Interesting Angles to Manufacture of Well-Known Ginger Ale

Ingenious Apparatus, Careful Supervision, and Purity of Raw Materials Are Required

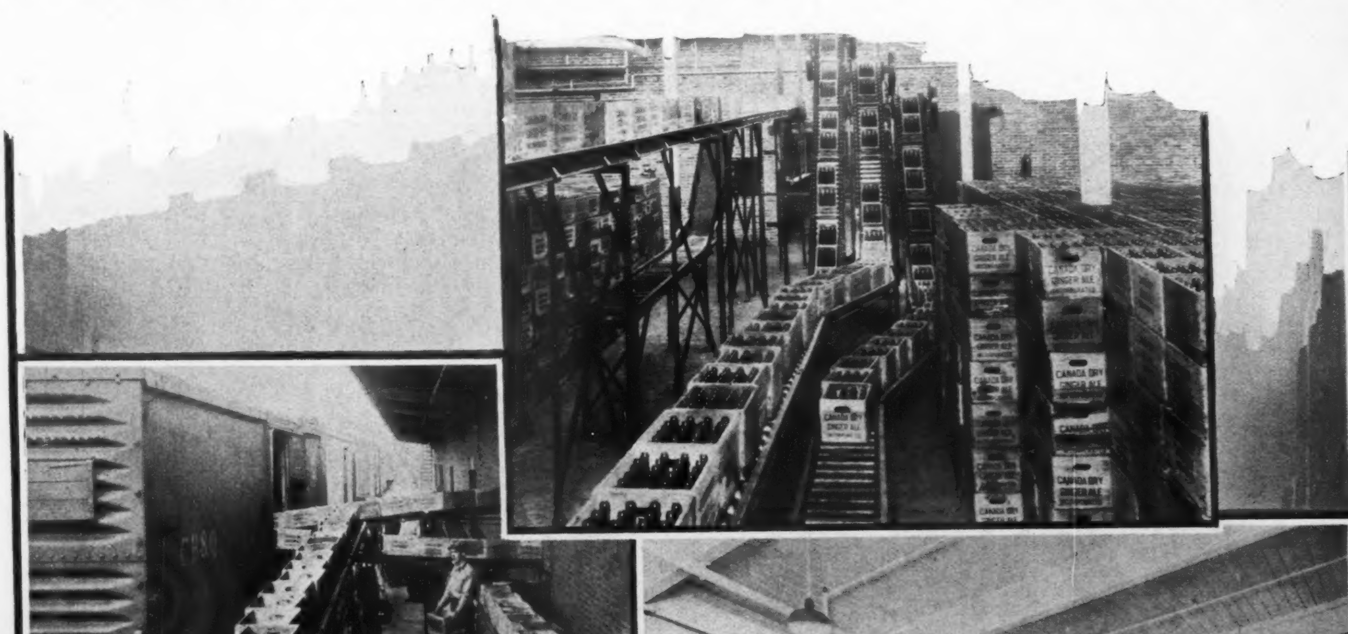
By R. G. SKERRETT

IN the days when our sea dogs were a hard-fisted lot, with cast-iron constitutions and copper "innards," one of them was asked what he thought of whisky. "Well, matie," he answered, "all whisky is good, only some of it burns your throat more than others."

That, in a general way, was also a pretty fit description of many of the ginger ales marketed in America not so many years ago. Whether or not all of those ginger ales were good must be left to the judgment of the individual; but it is safe to say that the majority of them were strong enough with capsicum—not ginger—to burn the average throat plentifully. As a rule, the ginger ales that then satisfied exacting palates were imported. Today, the situation is altered greatly for the better; and the author has seen for himself one plant in the United States that manufactures ginger ale for persons of discriminating taste.

Whether one's thirst be the result of the high temperature of summer, or due to the glow following pleasurable exercise in some form, still a tinkling glass of sparkling ginger ale can well-nigh invariably be counted upon to prove satisfying and refreshing. The story we are going to tell has to do with the manufacture of a beverage that is fittingly described as "The Champagne of Ginger Ales;" and it will help us to understand why that product is so dependably good.

About five decades ago, "Canada Dry" was first made in the neighboring country to the north of us; and, as time went on, that ginger ale won increasing favor in the Dominion because of its unfailing excellence. That beverage was produced with care, and was the outcome of a formula that experience confirmed to be especially pleasing to persons of rather exacting taste. It was made from the purest raw materials obtainable, and it owed its distinctive flavor to genuine ginger extract—not red pepper, and to just the right quantity of sweetening. Because of the characteristic flavor of the essential ginger syrup used to produce Canada Dry in Canada, the American company—Canada Dry Ginger Ale, Inc.—imports its extract from the Dominion so as to



Top—Empty bottles arriving from the cars and on their way to overhead conveyors.
Left—Unloading incoming empty bottles. Ten carloads are received daily.
Right—Bottles moving by gravity to the sterilizing machines.

be able to turn out a uniform commodity of identical taste and excellence.

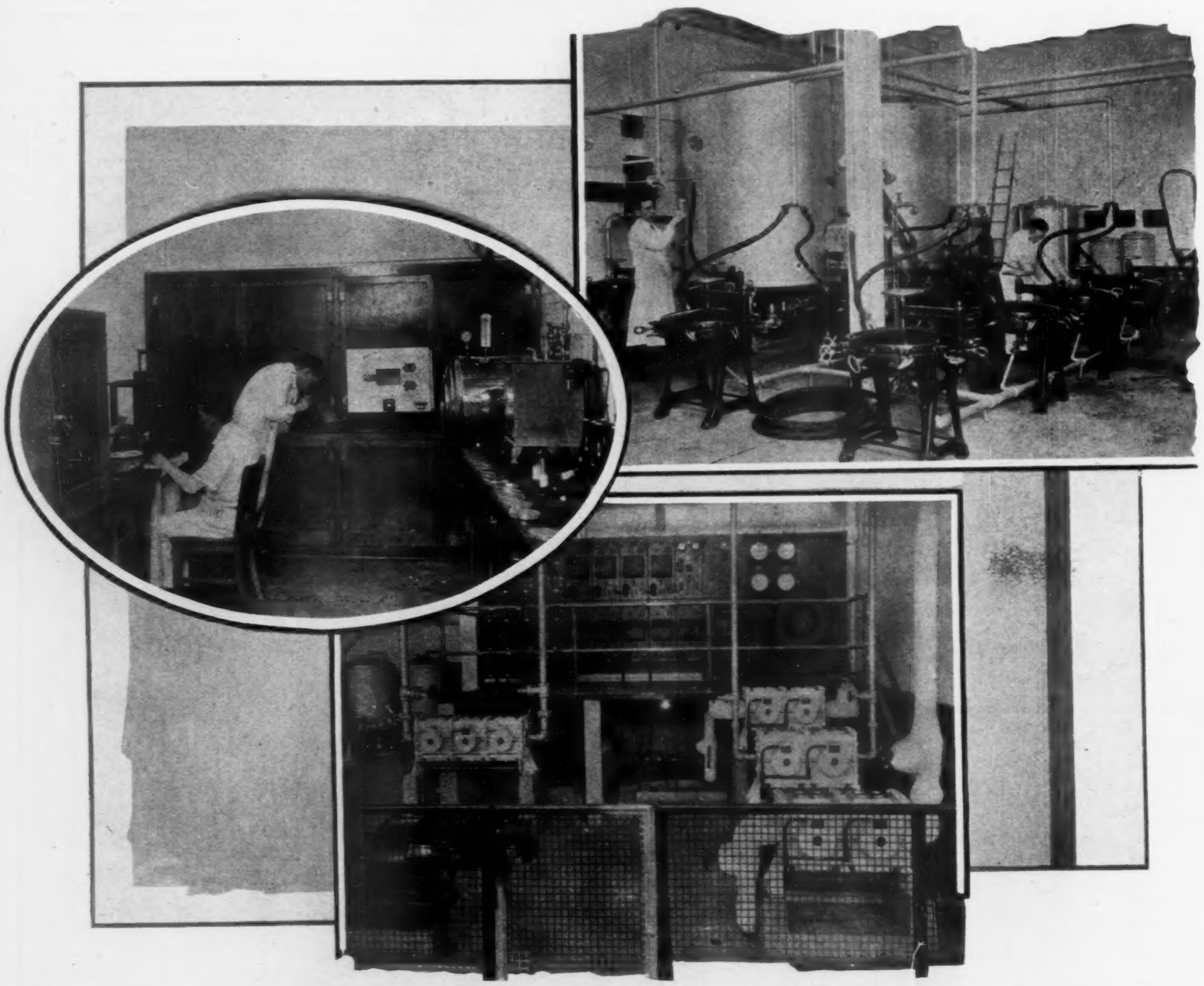
Relatively few of the people that appreciate a sparkling glass of good ginger ale have any idea how that beverage is made upon a quantity scale; and probably they are equally unaware of the painstaking care that must be exercised to insure an attractive, pure, and thoroughly enjoyable drink that can be sold at a reasonable price. At Hudson, N. Y., is located one of Canada Dry's immense plants. There ginger ale is produced at the rate of 800 bottles per minute—a day's output reaching more than 250,000 bottles when the plant is operating to capacity. One might imagine that with this rate of production it would be next to impossible to make a beverage of such uniformly high standard of excellence; but this is done, nevertheless—the result being due to the close coördinating of every contributive operation and to a supervisory sanitary control of manufacture that makes certain that all is right at every essential stage of production.

No small part of the success attained is attributable to the utilizing of mechanical facilities of different sorts that lighten labor and that limit, as far as practicable, recourse to manual effort. Some of the apparatus are veritable mechanical marvels, because they do a number of things and do them as though they were guided by a brain. As a consequence, the workers are not so wearied that they become careless or inattentive; and each and all of them remain fit during an entire shift to perform their several duties well and thoroughly.

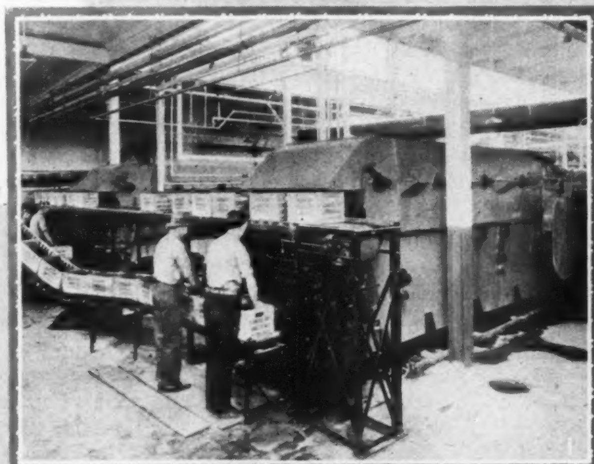
The casual visitor may come away from a ginger-ale plant with the idea that the commodity represents just so much extract syrup and so much carbonated water, firmly sealed in a bottle so that the gas in solution cannot escape until the cap or cork is removed by the ultimate consumer. That is true in a measure, but in only a very small measure. A number of important things have to be done, and done with care, before this stage of production is reached, if the marketable product is to be compared with Canada Dry .

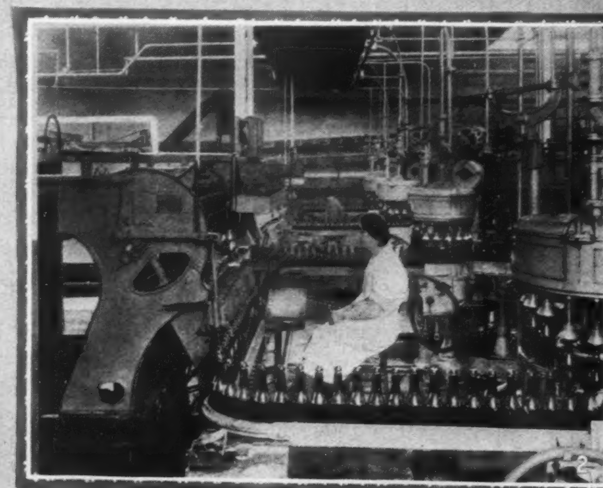
Perhaps, we can best give an idea of what is done at the Hudson plant if we follow the procedure through, step by step, starting with the arrival of raw materials in the form of carloads of box shooks, knocked-down cartons, bottles, sugar, etc., and see what happens between then and the time when the finished commodity goes into the storehouse on the opposite side of the factory.

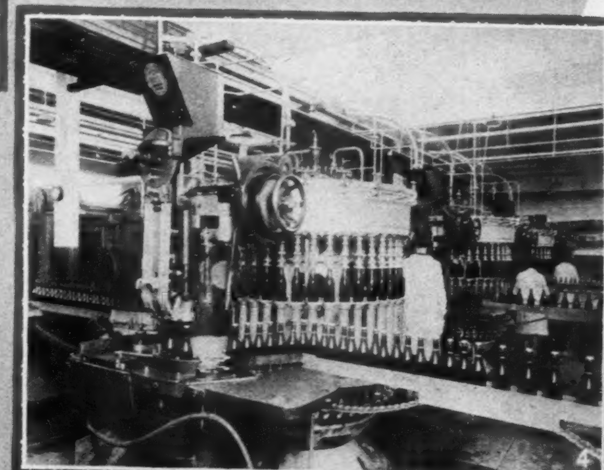
Adjustable conveyors reach into the loaded freight cars, and the arriving supplies are sent a short distance by gravity to power-driven elevators—part of the conveyor system—which raise the materials high enough to deliver them by gravity to a permanent part of the conveyor system which then moves the goods to a predetermined point either for immediate use or for a brief period of storage. To prevent confusion, let us follow through a carload of bottles, just arrived from a glass plant. To begin with, these bottles are made of high-grade glass, and are strong enough to be dropped on a concrete floor from a height of several feet without fracturing. This is of interest to the ultimate consumer, because it

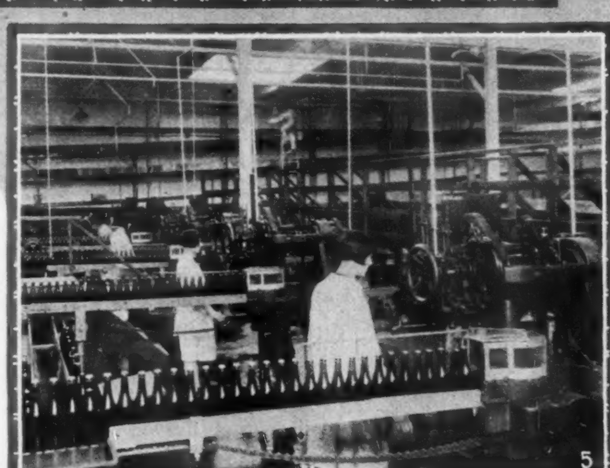


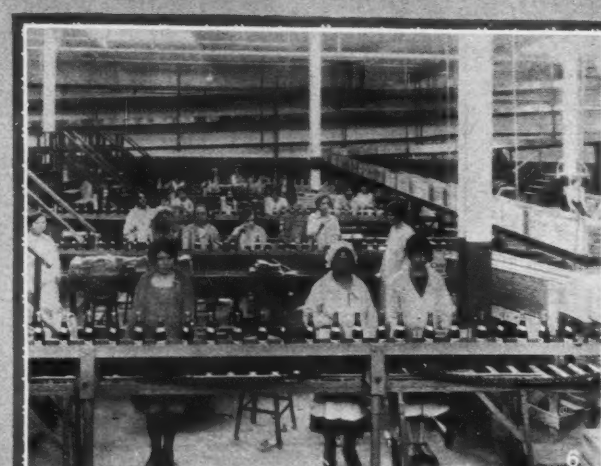
Top—Section of syrup room. One of the chemists may be seen observing the product. In the foreground is a group of mono-cell filters through which all water used in the plant must pass.
Oval—Sanitary and bacteriological control is exercised continually. The finished product is tested by chemists in the plant laboratory every half hour.
Bottom—Ultra-violet sterilizing apparatus. This artificial sunshine sterilizes the water after it has been softened and filtered.







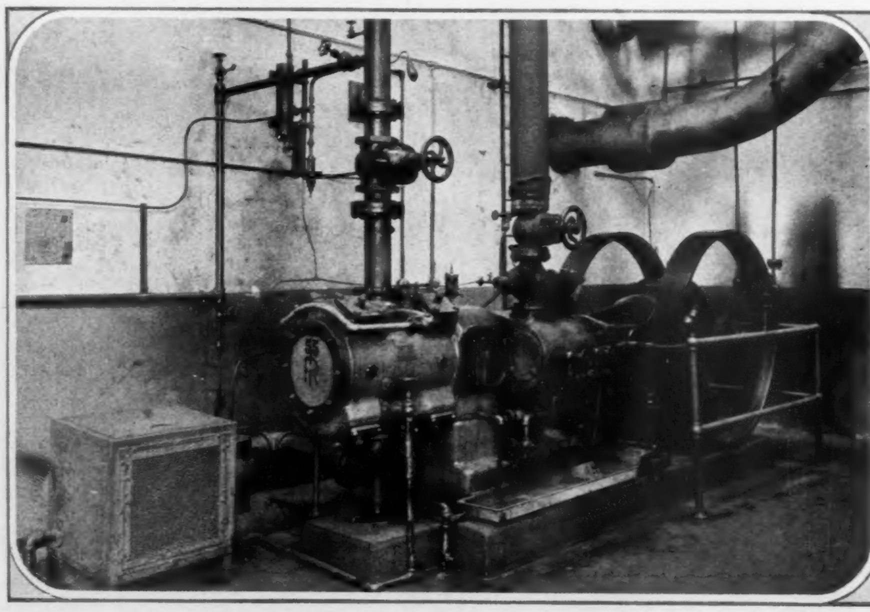




1—Bottles entering sterilizing and washing machines. From this point on no human hand touches the bottles until after they are filled and sealed.
2—The sterilized bottles are moved mechanically over electric lights at the rate of 160 a minute, and a keen-eyed inspector removes those that show defects.
3—Bottles arriving at syruping machines that automatically place in each bottle an exact measure of syrup and ginger extract.
4—At this station the bottles are filled with carbonated water and immediately capped and sealed. This is done at the rate of 80 bottles a minute.
5—Here are seen ceaseless processions of bottles moving to the labeling and foiling machines.
6—The finished product is here inspected on its way to the packing station. More than 800 bottles a minute travel along on the conveyors.

means that the bottles, when filled, will stand a good deal of rough handling without breaking, and it also means that the bottles are strong enough to confine safely the highly charged ginger ale—the notable measure of this charge insuring a sparkling and effervescent beverage.

The bottles end the first stage of their journey at one of the several washing and sterilizing machines. Each of these machines is divided into four compartments containing a chemical solution in which the bottles are successively submerged as they pass onward upon a mechanical conveyor. The strength of the solution in each compartment is graduated, and the temperature in each compartment varies so that the bottles will not be subjected to heat changes that are too sudden or likely to cause breakage. On issuing from the fourth compartment, each bottle is rinsed with sterilized water and scrubbed inside and out by an ingenious arrangement of mechanically operated brushes. From the time the rinsed and sterilized bottle leaves the soaker, as the machine is known, until it is filled and sealed, it is not touched by human hand. The steam valves of the automatic-temperature controls of the soaker are operated by compressed air.



The compressed air used for various services in the Hudson plant is furnished by a steam-driven compressor of the well-known FR-1 type.

From the rinser, the bottles move along on a conveyor to an ingenious machine, called a syruper. The clutch that rotates the syruper is actuated by compressed air; and as each bottle makes the circuit it receives a predetermined measure of ginger syrup—so much and no more. Just before the bottles reach the syruper they parade past a keen-eyed inspector—a young woman—who is ever alert for any defects that may make the bottle unfit for use. If any bottle is found unfit it is immediately removed from the conveyor. Each syruper is capable of handling 80 bottles a minute.

After leaving the syruper, the same conveyor system carries the bottles onward to the next machine, which is termed a crowner and filler, where each bottle is filled with carbonated water and then sealed with the familiar Canada Dry crown or cap. Compressed air is used on the crowner and filler to blow from the revolving table any bits of glass from broken bottles. Each of these machines will fill and crown 80 bottles a minute; and they are impressive examples of skillfully devised apparatus.

There is an instant's interval between the filling of a bottle and its sealing with the cork-lined metal cap; and the uninitiated will wonder why it is that the charged water does not fizz out before the cap is in place. The answer is, because the temperature of the water is pretty close to the freezing point. And to chill the water, the plant is equipped with two ammonia-refrigerating machines having a combined capacity of 150 tons of refrigeration. The water is not primarily made so cold just to keep it from effervescing out of the bottles during the filling process: the real purpose is to make the water so cold that it will absorb and hold in solution a greater volume of gas until crowned. This means that when the bottle is finally opened to slake some one's thirst it will then effervesce and continue to bubble like champagne, and be just that much more pleasing both to the eye and to the palate.

From the crowner and filler, the bottles are carried upon a continually moving conveyor into a tank, where they are submerged in water that is warm enough to give the bottles the room temperature. This bath serves the double purpose of promptly indicating, by escaping bubbles, any leaky bottles and of heating them sufficiently so that they will not sweat and cause the labels to twist and slip when they are placed upon them by the labeling machine. Before the bottles reach the foiling and labeling machine, they parade before a group of electric lights, and there another young woman inspector, with sharp eyes, watches for any bit of cork or any other foreign matter that may have been sealed within the bottles by the filling and crowning machine.

Assuming that all is right with the filled and crowned bottles, they continue their journey onward upon the conveyor and are delivered to the foiler and labeler. This machine wraps the top of every bottle with gold foil and pastes upon it the characteristic Canada Dry label. Each of these machines can foil and label 80 bottles a minute. Compressed air is provided at each foiler and labeler to blow particles of glass, paper, or foil from the revolving table.

Still continuing on their journey, the bottles pass before another inspector, one for each machine, who sees to it that the labels and the foil are properly placed upon every bottle. Where this work has not been perfectly done by the machine, the bottles are removed from the conveyor and the needful finishing touches are performed by hand—the bottles then being returned to the conveyor circuit to be carried to the wrappers, who cover each bottle with a protective cylinder of felt paper. The wrapped bottles then go by conveyor to the packers who put the bottles either in wooden boxes, holding 50 units, or in strawboard cartons containing 12 bottles. The latter are called "Hostess Packages," and are intended especially for household trade. The carton for a "Hostess Package" is closed and sealed, top and bottom, by a machine that does this with two glued strips of stout paper—after which the packages move about 20 feet between two belts that apply pressure to the top and the bottom of the package. This pressure makes doubly sure that the closure is a perfect and a lasting one. The wooden boxes move along a separate conveyor a short distance to a nailing machine, where the cover to each case is put in place and quickly nailed down. There are numerous mechanical nailers in the boxmaking department and at the final closing points. All these machines are directly driven by their own electric motors; and compressed air is led to each of them to blow the motors clean at frequent intervals.

It should be clear to the reader that an incoming empty bottle travels without cease from the time it is discharged from the loaded freight car until it is filled, sealed, and packed in either a wooden case or a strawboard carton. Its journey does not stop then, because the sealed box carton is transported by another conveyor system to the storehouse, where it must remain six months before it is considered ready to be shipped away to the consumers of Canada Dry. The purpose of this storage period is to give the beverage its notable mellowness. Again, when the goods in storage have mellowed or ripened to the desired degree they are, once more, placed upon a seemingly endless-conveyor system and carried, from their different points of storage to waiting freight cars that are to transport them to all parts of the United States.

We mentioned the use of sterilized water in rinsing the bottles after they emerged from the washing machines. Some one will ask: "How about the water that is carbonated and employed in combination with the ginger syrup to make Canada Dry?" The carbonated water, like the rinsing water, is also sterilized; and it

should be of interest to know how all the water is made fit that is used in the manufacture of "The Champagne of Ginger Ales."

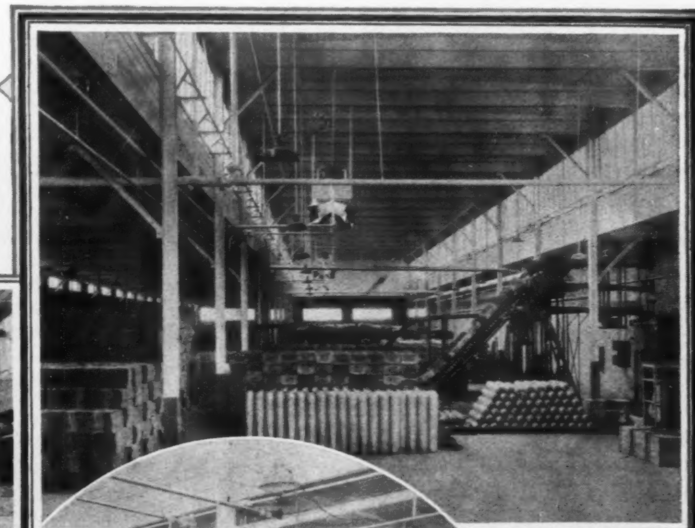
The water at the Hudson plant is drawn from two sources—from the city mains and from a spring situated up on the slope of a neighboring mountainside. No matter which the source, the water is first run through a zeolite softener, then through sand filters, and next it is further cleansed by going through a number of monocell paper and felt filters. These steps serve effectually to remove all solid matter in suspension; but that is not enough to satisfy the exacting standard set up by Canada Dry. After leaving the last of the filters, the water is sterilized by a battery of violet-ray lamps; and these apparatus have a combined capacity of 20,000 gallons an hour. From the time the water leaves the violet-ray sterilizers until it is delivered to the bottles by the filling machines it is not exposed to the atmosphere.

The precautions taken to make sure that all water used is pure and free from bacteria is in keeping with the care exercised continually during every stage of the production of this delectable ginger ale. Not only the manufacture of the ginger syrup but the quality of the production in its entirety is also under the supervision of an experienced chemist and bacteriologist at all times; and tests are made every 15 minutes either by the chemist or his assistants to be certain that everything is sanitary and in accordance with the very rigid conditions prescribed by Canada Dry.

Because of the extensive employment of motor drive throughout the different departments of the plant at Hudson, it is necessary to keep these numerous motors in proper condition to perform their interrelated and synchronized functions. Therefore, compressed air is depended upon frequently to blow them free of dust. The compressed air utilized for various purposes in the plant is furnished by a steam-driven compressor of the well-known FR-1 type, which has a capacity of 215 cubic feet per minute.

The employees of the Hudson plant form a happy family that is thoroughly interested in the work it is doing to add to the enjoyment of those thousands of people who know how really good Canada Dry is. The cheerful workers appreciate this, themselves, because they drink the ginger ale daily, during recess periods, to refresh themselves and to tickle their own palates. As is the case at the other plants of the company, a fully equipped dispensary, in charge of a graduate nurse, is maintained at the Hudson factory. The employees are protected by health insurance; and welfare work among them is carried on by one of the administrative departments. As has been justly said: "Canada Dry officials know not only how to make a premier soft drink, but also how to make good, happy, and loyal employees."

Right—Warehouse where are held in reserve more than 20,000 bags of sugar, several carloads of empty bottles, many tanks filled with carbonic-acid gas, etc.
Bottom—Finished goods reaching the reserve warehouse where they will remain for six months to undergo "aging." Nearly $1,000,000 worth of Canada Dry ginger ale is kept in this department.



Circle—Box-making department where 8,000 fifty-bottle boxes are assembled and nailed in the course of the average day.

FORESTS A PROTECTION AGAINST FLOODS

THE United States Department of Agriculture recently announced the results of a study just completed on a 112-acre farm, in Tennessee, showing that a relatively small amount of timber has a decided influence in reducing the rate of run-off of rainfall on watersheds.

The experts that conducted this investigation point to its value in determining the part that farm forestry can play in a program involving the control of erosion and the diminution of floods. The Department has long contended that proper forestation is an important factor in flood control; and has emphasized its importance following the Mississippi flood disaster.

The cork oak bears its best bark when it is about 40 years of age.

Shoveling With Compressed Air

By E. K. HARTZELL

COMPRESSED air has long been indispensable to mining operations. Wherever men delve beneath the earth's surface for minerals or drive openings into rock for any other purpose, air-driven rock drills assume a leading role. The present tendency is to widen the service of this important agency. Air-driven hoists and pumps are being employed extensively; and the air-operated mucking machine is now finding favor for underground use.

Among the loading machines that arouse interest is the Nordberg-Butler underground shovel, made by the Nordberg Manufacturing Company of Milwaukee, Wis. The designers have succeeded in producing a machine that will function well in close quarters and one that also possesses a digging and loading range which makes it readily applicable for service in larger tunnels or stopes. The aim has been to develop a machine that will answer the varied needs of the metal-mining industry in a satisfactory manner.

This type of shovel is full revolving, and is thus adaptable for the loading of cars on either side or directly back of the machine. It is of such compactness that it can be used in drifts as narrow as 5½ feet and as low as 6½ feet. At the same time, the extension of the dipper arms permits the machine to clean up a path 18 feet wide and thus makes the shovel suitable for work in larger openings. The mechanism is mounted on roller-bearing track wheels, and has an over-all weight of 4,600 pounds. The various movements of the dipper—such as lowering, crowding into the muck pile, filling, elevating, and dumping—are controlled by a single air cylinder. Two pistons within this cylinder can be operated as one, or separately—being responsive to manipulations of the main throttle valve.

Here we get a good idea of the size of the shovel. At the lower right is the I-R air motor that gives the machine its rotating power.

The revolving motion is imparted by an Ingersoll-Rand Size AA reversible air motor. This motor is mounted on the revolving element between the side frames and below the air cylinder, where it is protected from damage. A pinion on the revolving spindle of the air motor engages a stationary gear on the truck frame, and the entire assembly about the truck frame is thus made to rotate when air is applied. The lever controlling the motor is at the operator's right hand—that is, conveniently placed to secure the close regulation essential for proper digging and for accurate spotting when loading cars. The machine functions much like the familiar power shovel of larger size. The dumping action is effected by turning over the bucket instead of by a bottom release. This obviates the chance of large boulders lodging in the dipper.

This type of shovel is well adapted for the loading of ore or other material into mine cars.

The shovel is economical in air consumption: its requirements vary from 135 to 150 cubic feet per minute at from 70 to 90 pounds pressure. Most of the air is utilized by the air cylinder; and inasmuch as its action is in the nature of a direct thrust, the air is employed in the most effective manner. The air motor also is designed to operate with low air consumption.

The machine is easy to manipulate. There are but two controls: one for the main throttle and one for the revolving motor. The throttle valve is so designed that the positions of the control lever for the various movements follow in their natural sequence. This not only permits rapid operation but also enables a new man to master the handling of the machine quickly.

The dipper has a capacity of ¼ yard, and normally functions at an average speed of 3½ passes a minute. While the performance varies widely, according to conditions and the nature of the material being handled, anywhere from 15 to 30 tons per hour can be loaded. In general, the shovel is said to do the work of eight men with hand shovels. Some notable records for speed in driving drifts or tunnels have been made, so it is reported, by the aid of air-operated machines of this type. In one instance, a 6½x8-foot drift was advanced 523.5 feet in three weeks, working three shifts.

The human factor enters largely into the success or failure of mechanical loading equipment, according to officials of the Nordberg Manufacturing Company. It is their contention that no machine, regardless of its design and make-up, will give the best results when operating under adverse conditions. Where the attitude prevails that "it may be all right for some mines, but ours is different," the chances are that no mechanical loader, no matter how well designed and constructed, would succeed. However, where mechanical shovels have been thoroughly tried out, they have in most cases given satisfaction.

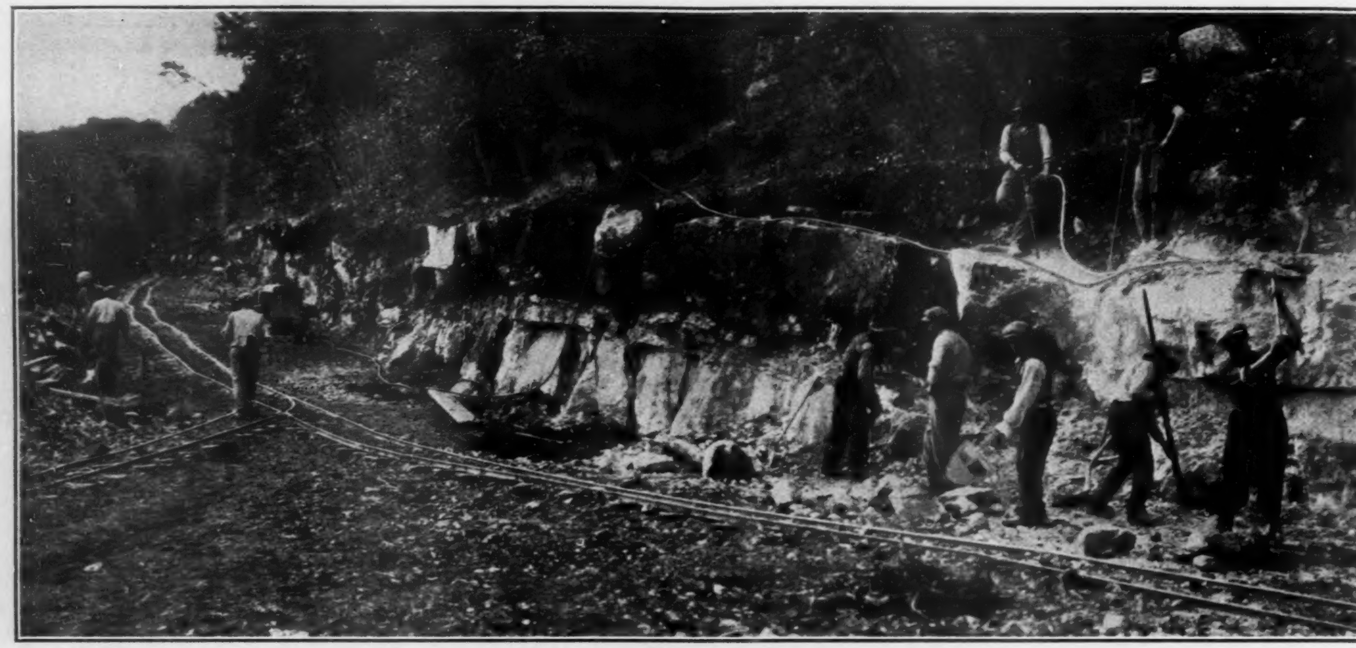
AIR SPEEDS UP OUTPUT OF PAPER MONEY

BY the liberal use of controlled air the Government is said to have placed the making of paper money on a mass-production basis. When big sheets of $5, $20, or $100 bills—wet with heavy ink—are taken out of the presses at the Bureau of Printing & Engraving, they are placed on racks in specially constructed cabinets where they are baked for three hours.

While undergoing this treatment, a fan blower sends thousands of pounds of air into each cabinet to dry the ink and to condition the money for circulation. These driers look like big safes, which are kept locked during the drying process. Anywhere from 150 to 200 of these driers are in service.

VIEWS SHOWING HOW THE AIR-DRIVEN NORDBERG-BUTLER SHOVEL OPERATES

1—Starting position, with the trucks anchored to the tracks.
2—The dipper crowding into the muck pile. This picture shows the wide reach of the machine.
3—The shovel folds into a compact unit of low over-all dimensions.
4—Bringing the load around from the left to the right side.
5—The dipper dumps by turning over instead of by a bottom release.



© Ewing Galloway, N. Y.
Building roads in the mountainous sections of southern France calls for the excavating of much rock. Here we see pneumatic "Jackhamers" at work drilling the rock—the motive air being furnished by an I-R portable compressor.

PNEUMATIC COMPASS FOR AIRCRAFT

A PRESS report from Berlin announces that the German airplanes that were unsuccessful in their first attempt to cross the Atlantic are equipped with a new telecompass that is said to enable an airman to keep his course mechanically. The compass is operated with compressed air, and is the product of the Askania Works of Friedenau, a suburb of Berlin.

The new compass differs somewhat from the induction compass, and this is explained in the following fashion by one of the officials of the Askania company: "Instead of being worked with the aid of electric currents, our telecompass is worked pneumatically. The equipment consists of three parts—the compass, itself, which gives the direction; the course indicator; and the course setter.

"The compass is fitted in the stern of the cockpit, where the effect of magnetic influences is at a minimum. Compensation, therefore, becomes unnecessary. All that the pilot must do is to adjust his controls so that the pointer of the indicator remains at zero. If an alteration in the course is called for, the pilot must alter the course of the setter."

The reclamation of battery lead has become an industry of no small proportions as well as one of considerable importance in the United States in view of the fact that no new lead deposits of any magnitude have been found in this country during the past 15 years. At one plant an average of 120,000 pounds of battery-lead scrap is handled daily.

It is estimated that the international trade in wireless apparatus in 1926 amounted to approximately $30,000,000. The four leading exporters were: the United States, with 29.4 per cent.; Germany, 25.6 per cent.; Great Britain, 20.5 per cent., and France, 13.7 per cent.

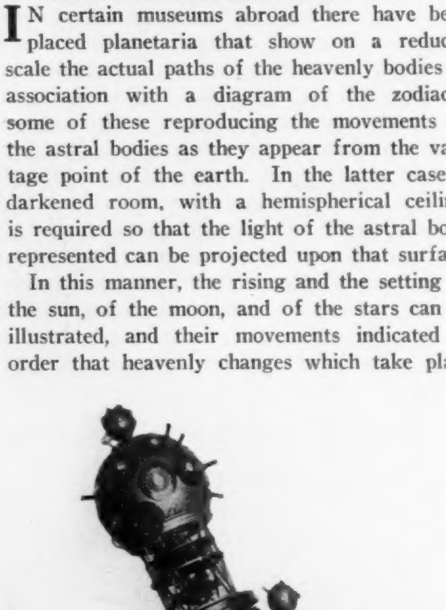
MOTION OF ASTRAL BODIES SHOWN MECHANICALLY

IN certain museums abroad there have been placed planetaria that show on a reduced scale the actual paths of the heavenly bodies in association with a diagram of the zodiac—some of these reproducing the movements of the astral bodies as they appear from the vantage point of the earth. In the latter case, a darkened room, with a hemispherical ceiling, is required so that the light of the astral body represented can be projected upon that surface.

In this manner, the rising and the setting of the sun, of the moon, and of the stars can be illustrated, and their movements indicated in order that heavenly changes which take place naturally in the course of 24 hours can be compassed during an interval as short as four minutes.

According to the *Engineering & Mining Journal*, it is possible with certain of these machines to show the whole heavens of two hemispheres. "One can be taken on a meridional journey over the North Pole, down the other side of the earth, crossing the South Pole, and returning to the point of beginning. At each latitude, northern and southern, the planets run their courses so that one can see where they appear at any time of the year, be he at the North Pole or the South, the equator or anywhere in between.

"Further, the precession of the equinoxes is provided for in both machines, and one can see how the heavens will appear, from a given place on the earth, 1,000 or 5,000 or 10,000 years from now. The North Pole, be it remembered, shifts in the heavens over a long period, thus changing the position from which we see the fixed stars."



Courtesy, Copper & Brass Research Ass'n.
This is neither a scepter nor a bejeweled dumb-bell, but a complicated brass planetarium projector made by a well-known optical concern in Europe to facilitate the study of the movements of astral bodies.

CANADA'S COMMERCIAL DEVELOPMENT

INTERESTING statistics relating to Canada's growth since her confederation 60 years ago have been given out by the Trade & Commerce Department of the Dominion. The tables prepared by the government show that from an isolated region Canada has grown to the status of a nation doing business with well-nigh the entire world.

Today, in volume of trade, she ranks fifth among the commercial nations—being exceeded only by the United States, Great Britain, Germany, and France, all countries with populations ranging from 35,000,000 to 115,000,000, as compared with the Dominion's 10,000,000. Since 1867, her trade with the United States has increased 24 fold or, to be more explicit, from $48,009,700 to $1,167,039,099.

How Rock-Drill Steel is Made in Sweden

Purity of Ore and Skill in Mill Produce Steel of Surpassing Excellence for Ingersoll-Rand Company

By H. S. BRAINERD

IN mining, in quarrying, and in excavating work for many purposes, the air-driven rock drill is indispensable. But, in the last analysis, the successful performance of this really remarkable tool or machine depends upon the character of the drill steel that actually penetrates the ledge. To do its part effectually, the drill steel must be of a superior sort from a metallurgical standpoint.

The accompanying article describes how drill steels of such excellence are produced in a certain Swedish mill. In that country, Nature has been especially generous in providing an abundance of necessary raw materials that make it possible to produce, in the first place, pig iron of exceptional purity. In addition to this, the Swedish iron and steel industry has fostered, through generations, a mill personnel of notable skill and one that takes much pride in the high standard of output.

THE rock drill of today can do its best only when equipped with drill steel of a superior sort; and the drill steel, to do its part effectively, must have its shank and bit correctly formed to meet rock conditions. Furthermore, the steel must be properly heat treated so that the metal will stand up against the driving blows of the drill piston and the opposing resistance offered by the rock being penetrated.

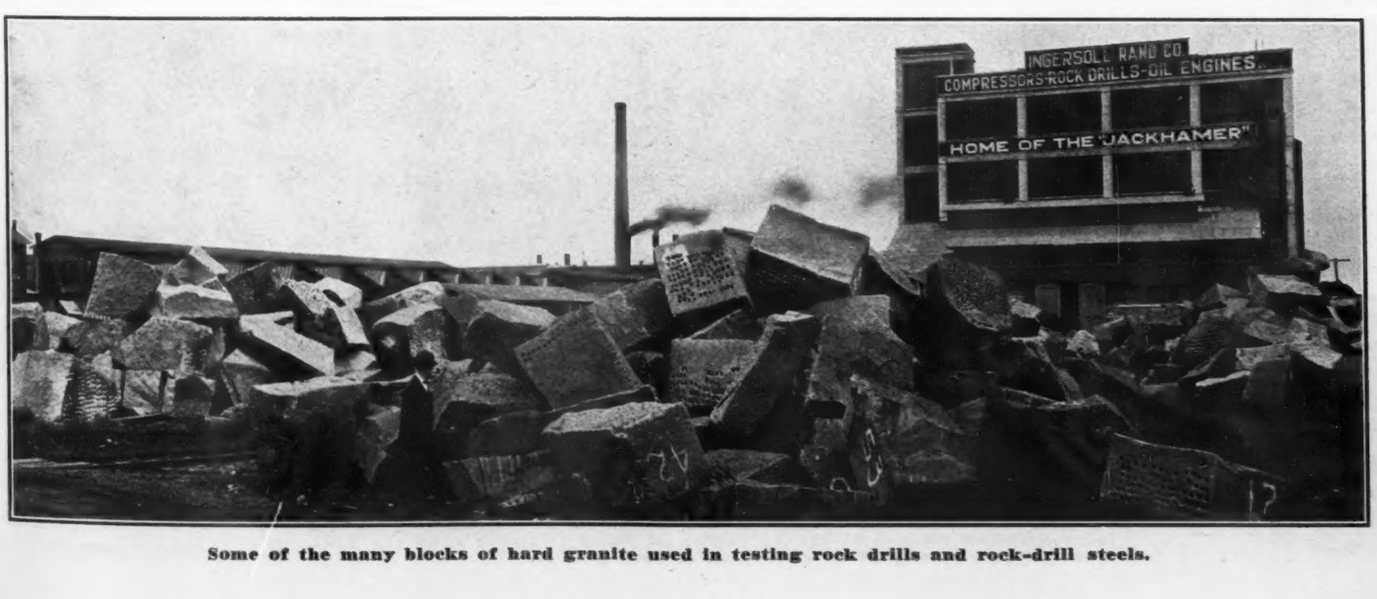
The forming of the shank and the bit, and the heat treating of the steel afterwards are the work of the blacksmith; and, manifestly, the efficiency of the drill in service will depend largely upon what the blacksmith finally does towards making the steel ready for the drill runner. In other words, the blacksmith is a specialist; and he must first have at his disposal steel of an excellent quality so that his skill in forming and in heat treating the steel may contribute in full measure towards footage.

In the belief that the purchasing agent, the mine operator, the contractor, and the indispensable blacksmith would like to know what the Ingersoll-Rand Company has done to make its rock drills equal to the utmost demands that can be made upon these machines, the following sketch has been prepared descriptive of the source of the drill steel sold by that company and of the manufacturing methods employed by the Swedish plant from which that steel is obtained.

It is generally acknowledged that certain Swedish steel is incontestably better than any other steel on the market today; and the drill steel distributed the world over by the Ingersoll-Rand Company is produced in a Swedish works that has an unsurpassed reputation among the quality steel mills of that country. The selection of this steel for rock drills was not through chance: the choice was the outcome of years of careful search for a steel that would be of the same high standard as that reached by the rock drills manufactured by the Ingersoll-Rand Company. Indeed, this quest for a really superior steel was, in a sense, a necessity, because it was early realized that the further development of the drilling machine depended, to a large extent, upon the discovery of a steel that would have sufficient endurance to stand up under the extremely exacting duty imposed upon the steel by the steadily growing power of machine drills. That is to say, the engineer could go no further profitably in devising rock drills until the metallurgist could offer a drill steel equal to the work expected of it when exposed to very severe and rapidly repeated stresses. The solution of this many-sided problem lay in adopting Swedish steel, and in buying that steel from a source of exceptional excellence.

The foundation on which the fine tool-steel industry of Sweden rests—and which will likely long continue to be its chief support—is the purity of the iron ore used, together with the employment of pinewood charcoal as fuel. Nature has helped Sweden to her preëminent position in this matter by giving her not only vast forests but great deposits of iron ores that are very low in phosphorus and sulphur—elements that are undesirable and which the steelmaker usually does his utmost to get rid of either when smelting the ore in the first place or while the metal is undergoing treatment in the furnace of the steel mill.

Although the Swedes have at their disposal a great deal of low-priced current, still they do not pin their faith on the electric furnace in



Some of the many blocks of hard granite used in testing rock drills and rock-drill steels.

producing high-quality steel, as is done elsewhere when ordinary coke iron, made from ores relatively high in impurities, is used. The Swedes, on the contrary, depend upon the purest raw materials obtainable; and handle these in a way to insure the best results. In the case of Ingersoll-Rand Swedish steel, the steel is made from ores mined from the famous deposits at Bispberg, Koluingberg, and Stripa, in Central Sweden, and from Tuollavaara in Lapland.

The first stage in the manufacture of drill steel in the Swedish plant is the treatment that is given the ore in Westman roasting furnaces, which have a capacity of approximately 40 tons a day. The charge is heated to about 1,800° F., and is held at that temperature for a number of hours—the purpose being to reduce further the already low sulphur content of the ore.

The second stage in the manufacture of drill steel is the production of pig iron in blast furnaces that have a capacity of about 25 tons a day. In this department of the plant the slogan is: "Quality, not quantity." A visitor, accustomed to American coke-blast furnaces capable of producing from 500 to 800 tons a day, is invariably astonished at the relatively small size of the units employed in this Swedish plant, to say nothing of the care taken in weighing the charges of ore and of charcoal. The blast temperatures in the small furnaces range from 575° F. to 675° F., instead of being in the neighborhood of 1,000° F., as is the case in coke furnaces. It should be readily realized that the reduction process is better accomplished in these small furnaces and that, as a result, a pig iron of superior quality is thus obtained.

The refining of the ore on such a small scale, together with the use of well-screened charcoal as fuel, permits the blast-furnace manager to have well-nigh exact control of his heat; and, as a consequence, he can be sure of that high grade of pig iron so necessary in the manufacture of drill steel.

Ingersoll-Rand drill steel is an acid open-hearth product. The refining process is carried on in Martin reverberatory furnaces, of 14 tons capacity, that use producer gas as fuel. Again, the employment of units of such comparatively moderate size is a necessity in the production of high-grade steel, and makes it possible to exercise strict control of the process.

Testing the hardness of drill steel with a Brinell ball-indentation machine.

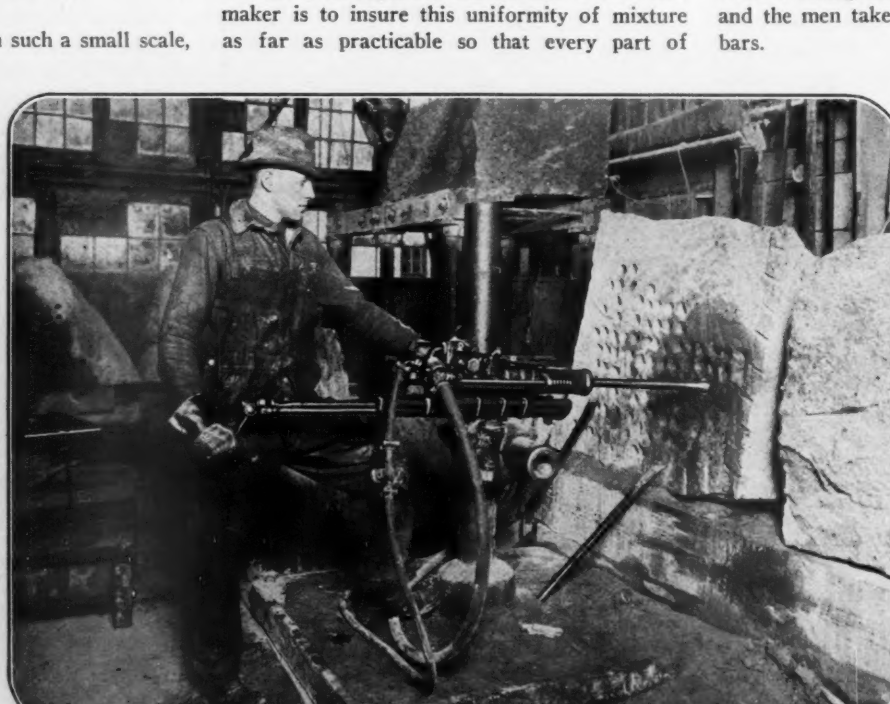
By adopting the practice of teeming into small ingots, the objectionable segregation which is found in large ingots is thus obviated, and, as a result, a far more homogeneous product of the highest grade is secured. Perhaps, it would not be out of place here to explain why there is this difference between the steel of large and of small ingots, even though the original composition be the same.

It is the uniform distribution of the components of a steel that give it its desired characteristics throughout; and the aim of the steelmaker is to insure this uniformity of mixture as far as practicable so that every part of bloom, billet, or bar shall have identical physical properties. When large instead of small ingots are cast, the period of "freezing" or solidifying is longer; and it is during this transformation from the liquid to the solid state that certain of the constituents of the steel tend to move toward the point where solidification takes place last. The longer this movement continues the greater is the resulting undesirable segregation, and the more pronounced is the lack of uniformity throughout the bloom. Small ingots, on the other hand, "freeze" rapidly; and segregation is negligible because the interval between the molten and the solid states of the metal is too brief for the movement mentioned to take place.

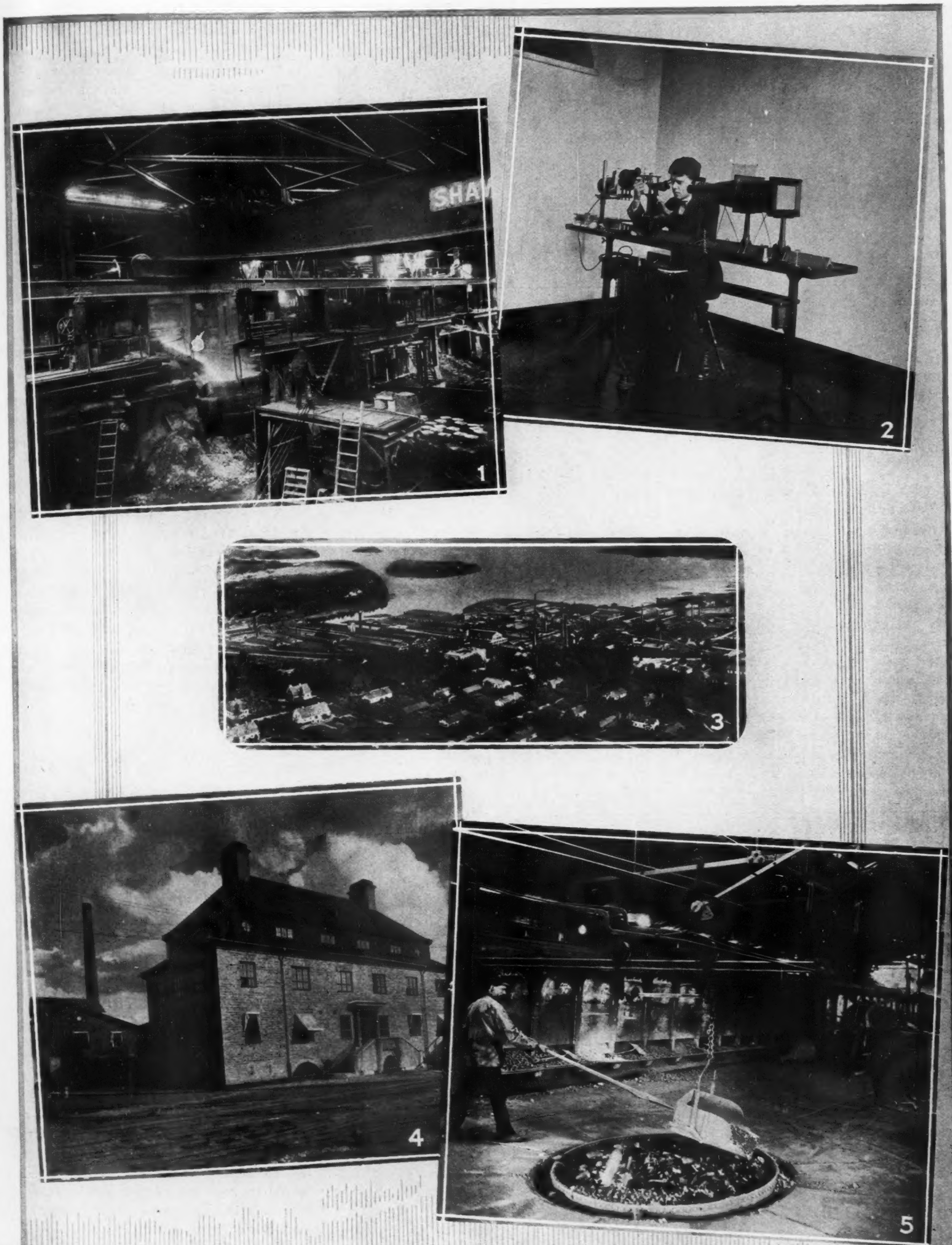
In producing hollow drill steel, most mills employ the sand-core process, but Ingersoll-Rand Sandviken steel is made by the mandrel process. The procedure is as follows: The ingots for the drill steel are taken to the rolling mill where they are slowly and uniformly heated. When sufficiently heated, the ingots are cogged down to about 4 inches round, generously cropped, and then cut into multiples by means of a hot saw. The steel is then thoroughly reheated and, while still hot, each piece is pierced. After cooling, the billets are carefully inspected inside and out, and such defects as exist are removed by chipping. Next, the hollow billets are again reheated and sent to the tube mill where they are rolled 10 times over a mandrel—successively decreasing in size. With this work done, the blooms are inspected for size and for any defects that may have developed. The last rolling is made without a slug or mandrel. The utmost care is exercised during each and all of these operations; and the men take infinite pains in handling the bars.

This process of rolling drill steel over a mandrel produces a fine-grained structure in the center as well as on the outside of the bar; and this helps in part to account for the durability of this particular kind of drill steel. After straightening and cooling, the ends of the bars are liberally cropped; and an elaborate system of inspection follows in order to make sure that the steel will meet every requirement of hard service.

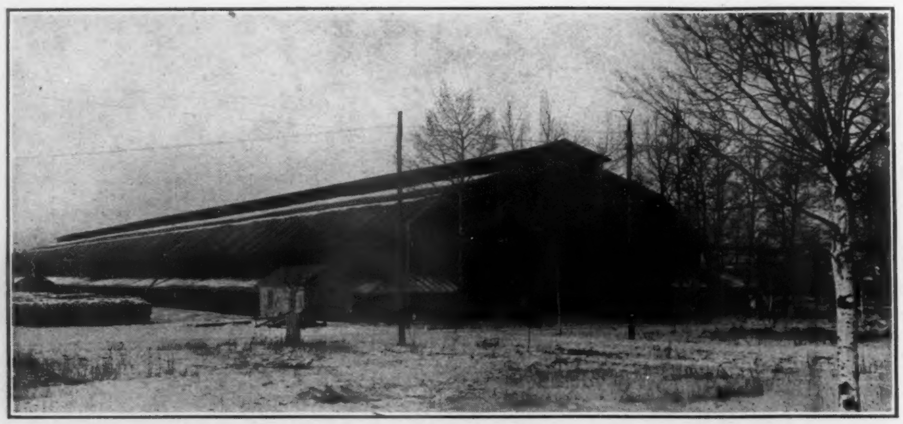
All too frequently, it is proclaimed that there is no sentiment in business, but, curiously, a great deal of it does exist in the plant where Ingersoll-Rand hollow drill steel is manufactured. The workmen in



How rock drills and drill steels are tested at the Phillipsburg plant of the Ingersoll-Rand Company. In the course of three 1-minute runs the drill must penetrate to a prescribed depth a block of hard granite.



1—Tapping a 12-ton Martin open-hearth furnace in the Sandviken plant.
2—Examining drill steel with a metallurgical microscope.
3—Sandviken plant where Ingersoll-Rand Swedish drill steel is made.
4—The metallurgical laboratory at Sandviken.
5—Blast-furnace department showing how the charging is done by hand.



Where the charcoal used at Sandviken is stored to protect it from the weather.

the mill have a strong sense of attachment to the mill and a loyalty to the product which is evidenced in many ways even though the feeling may not be outspoken. This intangible sense of obligation, this faithfulness to quality and reputation have their reflex on the entire body of the personnel. This is understandable when it is recalled that the workers for several generations have been identified with the establishment.

The boys in the mill have been familiar from the earliest days not only with the terminology of the steel mill but also with many of the fine points in connection with the manufacture of steel. In short, the boys are virtually brought up in the atmosphere of the steel mill, and so they are really not novices when they start to work there. The beginners quickly follow in the footsteps of their elders. With skilled workmen developed in this manner, with steelmaking a family tradition, it is not hard to understand why Ingersoll-Rand Sandviken hollow drill steel is of such outstanding excellence. It is not only a product made from the purest materials obtainable, scrutinized painstakingly at every stage of its manufacture, but into each piece of that steel is wrought the pride of a jealously guarded craft.

Because of this manufacturing background, buyers of Ingersoll-Rand Sandviken hollow drill are assured the best material of its kind that can be had; and the blacksmith can be equally certain that he has for his expert handling a drill steel that will enable him to display his skill and his special knowledge to the fullest advantage. He, too, can take pride in the part he plays in making the work of the drill runner a success.

Figures compiled by the Interstate Commerce Commission reveal that the value of the railroad systems of the United States has reached the staggering total of $22,000,000,000.

Sinews and ligaments of silk are among the newest things in surgery, and may be used safely as substitutes for those tissues in the human body.

Inspecting hollow drill steel for dimensional accuracy.

STREET CARS OF MILAN TO RUN UNDERGROUND

THE rapid growth of Milan, Italy, coupled with her numerous narrow and crowded streets, has compelled the city authorities to seek some form of traffic relief. To the commission appointed in January of this year to investigate the matter the logical answer to the problem was subways; but the subways that have been planned are not of the usually accepted type.

The scheme recommended by the commission, and which has been approved and adopted by the municipality, involves the driving of two tunnels to carry the four principal streetcar lines that converge toward the Piazza del Duomo—the heart of the city. One of these tunnels is to have a length of approximately 2 miles and the other of 1¼ miles, and both will bisect the Piazza del Duomo.

The tunnels are to be large enough to accommodate double tracks; and the platforms at the principal stations are to be 262½ feet long and 11½ feet wide. When ready for operation, the old cars are to be run for a year or two when a new type, now undergoing trial trips, is to be put in service.

Every effort is being made to get the work underway before the end of 1927 and to push it to completion within a period of 24 months so as to relieve as soon as possible the steadily increasing congestion that is and has been for some time past a serious inconvenience, if not menace.

PROGRESS OF WORK ON PORT OF ANTOFAGASTA

SUBSTANTIAL progress has been made in the construction of the new protected port at Antofagasta, Chile. The first contract, calling for the building of a long breakwater, has been completed at a total cost of $8,168,000. This work included a large amount of filling in so as to provide the space for sidings, for the emplacement of port machinery and of other necessary equipment, etc.

The second contract, involving an expenditure of $10,904,000, specifies the building of a breakwater and three piers, the deepening of the water near the shore line, and the construction of sidings, warehouses, customs stations, etc. The entire project is to be finished within two years.

AIRPLANE PILOTS MUST CARRY LICENSES

THE first list of pilot licenses issued by the Aeronautics Branch of the United States Department of Commerce includes 333 names, although more than 2,000 applications have been received. The licenses were issued following inspections and examinations by representatives of the Aeronautics Branch, and authorize the holders to operate private, transport, or industrial planes.

Pilot License No. 1 was issued to Assistant Secretary of Commerce for Aeronautics, William P. MacCracken, Jr.; and Charles A. Lindbergh, who is listed as a transport flier, received License No. 69.

COMPRESSED AIR LIGHTENS LABOR IN THE HAGUE

Streets in the capital of The Netherlands undergoing repairs. Ingersoll-Rand paving breakers and portable compressors have won favor with the Hollanders because they make it possible to save money and to expedite work.

CONCRETE "LUMBER"

FOR years experiments have been carried on for the purpose of producing a concrete "lumber" suitable for the construction of houses. It is now reported that such a building material was used recently in the construction of a dwelling at Manhasset, L. I.—the "lumber" having been made by the Winget method developed in England. We are indebted to *Rock Products* for the following interesting facts on the subject:

"Engineers went to Manhasset, L. I., not long ago to see workmen take precast concrete slabs of board size and house wall high; place them on end; and bind them in place by steel bonds woven through projecting ribs on the inner side—forming in this way a fireproof house and one having all the sanitary advantages offered by masonry construction. Not only were the walls laid up in this manner, but the floors and partitions as well were thus assembled at a cost of about 44 cents a cubic foot.

"It was demonstrated that only 41 of these full-size building units were needed for the walls of a house, which is 26x26 feet. Furthermore, the units were set in place and bonded by three unskilled and untrained laborers within three days.

"The average house, for example, requires in its construction about 75,000 separate units, but the engineers who visited the scene of the demonstration last week were impressed with the claim that under this new system of building at least 30,000 of those units could be dispensed with—thus making it possible to erect a building with 8-inch walls at 28 cents a cubic foot, or one stuccoed on the outside at 44 cents a cubic foot. The panels and shorter lengths also play a part in the construction of the airways, both interior and exterior. Thus a completely fireproof house can be artistically built at approximately the cost of frame.

"The research work of Professors Beyhr and Kreyfield, and of Joseph Winston, C. E., was most exhaustively carried out; and during their experiments some very interesting and important discoveries were made of hitherto unknown possibilities of reinforced concrete. For instance, they succeeded in producing a reinforced-concrete T-shape which bent and reacted in all respects like steel. It is this T-shaped reinforced-concrete unit that they are making use of in the Manhasset demonstration."

In a lecture read not long ago on the relative merits of steel and wood as a material for pit props, before the Midland Branch of the National Association of Colliery Managers, England, it was pointed out that it was not possible to reduce roof support at the face to exact engineering figures as could be done in the case of load supports generally. But as to the relative merits of timber ordinarily used and the steel prop designed to supersede it, it was found that there was a margin in favor of the steel prop of approximately 4 inches yield and 15 tons carrying capacity—an increase of 100 per cent. on both counts in efficiency.

Montreal has been selected as the site for an airship mooring mast to be erected by the Canadian Government at an estimated cost of $375,000.

Special Service Car For Electric Railway

FLAT wheels are not only a source of objectionable noise as they hammer away at the supporting rails, but flat wheels are damaging to the track, a source of discomfort to the passengers, and a means of more or less seriously jarring the mechanism and the structure generally of the cars they carry. Therefore, it is to the advantage of a railway company to remove flat or worn wheels as soon as practicable and to replace them with wheels in first-class condition. Again, it is equally desirable for a street-railway company, for example, to remove defective motors promptly and to install in their stead other prime movers capable of doing the rather exacting work expected of motors in service of this sort.

To the end that worn wheels and defective motors can be dealt with with the least delay, the Chicago Rapid Transit Company has equipped what that public-service corporation calls the *S-5*. This car is used to transport mounted wheels and motors to and from all sections of the company's rapid-transit system. The wheels and motors so handled are hauled to center repair shops; and when these wheels and motors have been made fit for re-use—if that be possible—they are returned to points along the system where slight repair jobs are taken care of. Of course, the primary purpose of the *S-5* is to perform this interrepair-point service in a way that will occasion the least amount of interruption to the tide of regular rapid-transit traffic. Besides being a better-looking piece of equipment than the ordinary car employed for similar work, the *S-5* has proved a great time saver. It is self-propelled, and so arranged that it can draw operating current either from an overhead wire or from a third rail.

In order to handle car wheels or motors, the *S-5* is provided with an extendable I-beam that serves as a derrick; and this I-beam carries a standard Ingersoll-Rand D6 air hoist. This hoist is easily capable of dealing with a pair of wheels weighing 3,050 pounds. With the single-cable hook-up, shown by one of the accompanying illustrations, a lift of 22½ feet was made in 62 seconds. The air pressure at the start was 150 pounds, and at the finish the gage on the receivers indicated 87 pounds. When loading a motor, which weighs about 6,000 pounds, a standard double-cable hook-up is used. The change from single cable to double cable has been made in 28 minutes.

Interior of the "S-5" showing air tanks on each side near the roof, and with the extendable I-beam and air hoist housed.

For the purpose of providing a better rolling surface for the trolley wheels carrying the air hoist, the bottom flange of the I-beam was machined. This, of course, considerably lessens the effort required to run into the car or to run out of the car either a pair of wheels or a motor. Further, as a precautionary or safety feature, two stop levers are installed to keep the I-beam from shifting. The picture illustrating the interior of the *S-5* shows how wheels are placed in the car and braced to keep them from moving when underway.

In order that the *S-5* shall be thoroughly self-contained, it is equipped with a standard electrically driven car compressor. The air compressed by this unit is held in cylindrical overhead tanks or receivers, at a pressure of 115 pounds. These receivers are mounted on each side of the car just under the roof. Should the car compressor be out of service, or should it be desirable for one reason or another to obtain compressed air elsewhere, it is possible to connect the car air line with an outside air line of a shop or some other convenient source of compressed air. The air hose for the hoist is supported by trolley hung from a cable stretched at one side and from end to end of the car beneath the roof beams. The success of the *S-5* should prove of interest to the managements of other rapid-transit electric-railway systems.

India produces anywhere from 65 to 70 per cent. of the world's supply of sheet mica, which is obtained from a section of the Province of Bihar about 12 miles wide and 70 miles long.

An air-mail service has been inaugurated from Rimouski, on the St. Lawrence, to Montreal, Ottawa, and Toronto. The 'planes used are capable of carrying 500 pounds of mail matter.

Left—Chicago Rapid Transit Company's wheel car "S-5," with the end doors closed and the hoisting equipment housed. Right—The car in action lifting a pair of wheels by means of a standard Ingersoll-Rand D6 air hoist.

Philadelphia Boasts New Large Terminal For Perishable Products

Two Trunk Lines Have Combined to Build a Warehouse With a Refrigerating Capacity of 1,300,000 Cubic Feet

By S. G. ROBERTS

PERISHABLE foodstuffs form a large part of the daily dietary of most Americans. These foodstuffs reach the focal points of redistribution from all sections of the country, and even from foreign lands. Trade in such commodities is growing steadily; and special facilities have now to be provided at receiving centers so that these foodstuffs may be held for varying periods under conditions that will prevent deterioration. This means utilizing refrigerated storage space susceptible of being chilled to the right temperature to safeguard fruits, vegetables, etc., from spoiling while awaiting reshipment or delivery to local consumers.

Philadelphia has long been noted for the good things it has to offer either a keen or a jaded appetite; and its markets are calculated to make the hungry rejoice because of the abundance and the variety of the tempting comestibles on display. In latter years, this appeal to the stomach through the eye has become increasingly irresistible; and, as a reflex, the Philadelphian has grown insistant in his demands for the best and the earliest that near and distant farms and orchards can offer.

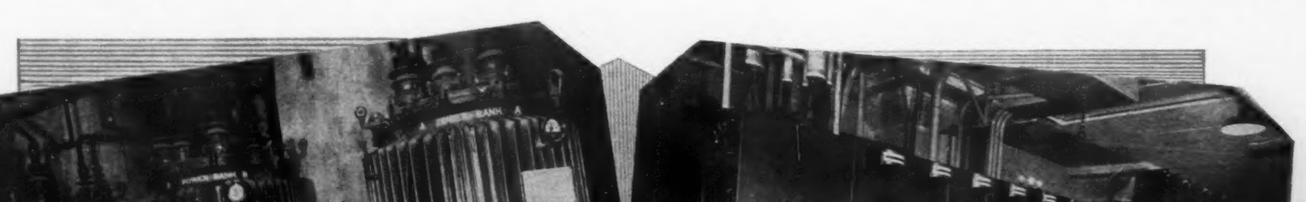
He has been favored because trunk lines from all parts of the country converge upon the Quaker City; and oversea and coastwise steamship lines also bring to that port perishable produce from many climes. Notwithstanding the extensive cold-storage facilities of Philadelphia, the Baltimore & Ohio and the Philadelphia & Reading railroads realized that still other accommodations were needful for the temporary storage of perishable foodstuffs arriving at that port and largely intended for redistribution to inland towns and cities.

Therefore, those two enterprising lines have called into being terminal-warehouse facilities capable today of providing 1,300,000 cubic feet of refrigerated space. This terminal is typically modern in all its equipment; and should prove a boon not only to Philadelphia but to all those other communities that depend in a measure upon Philadelphia for many of the things that fill their larders and appear upon their tables. The terminal plant, in its entirety, is made up of three prime units—a large auction sales building, and a large private sales building that will ultimately be linked with the existing cold-storage warehouse, the third unit, when the capacity of that warehouse is increased to 2,600,000 cubic feet of refrigerated space. That is to say, the present cold-storage warehouse represents only half of the projected major structure—the remainder of which will probably be erected next year.

The existing cold-storage warehouse is 90 feet wide and 218 feet long. It is eight stories high—seven of them being storage floors and one of them being a loading floor. Each cold-storage floor is divided into three main divisions; and each of these compartments is insulated with cork so that the separate divisions can be kept at a temperature suitable for the goods held in each. One room on each floor is used as a freezer; and the two other compartments serve as coolers. To meet the differing requirements it is possible to maintain temperatures ranging from 10° below zero Fahrenheit to 40° above. The warehouse is lighted throughout with electricity. The structure is equipped with an automatic dry sprinkler system—compressed air being utilized to hold the water out of the pipes until released by a rising temperature, indicating fire or near combustion. An air compressor for this service is installed in the basement of the building.

The ventilating air in the cold-storage compartments is dehumidified. This makes for the surer preservation of many kinds of foodstuffs that may be held in storage directly in contact with the air. Both of the high-temperature rooms on each floor are, therefore, equipped with the Moore system of room dehumidification. Each large room is provided with a 14-inch Moore brine-coil appliance with a fan, complete with galvanized ducts, wall jacks, etc. The smaller triangular rooms are fitted with the 12-inch-size Moore system. The Moore 3-tube, brine-coil, forced-gravity ventilating appliance functions in conjunction with the coil arrangement housed in the bunkers. Baffles are fitted to direct the circulation of the atmosphere within the rooms, and they function in conjunction with the ventilating system.

The elevators are of an enclosed type so that



Left—General Electric transformers that step the current down from 13,000 volts to 440 volts. Right—General control switchboard composed of sixteen panels.

Mr. A. F. Saunders, Operating Manager of the Baltimore & Ohio-Reading Perishable Products Terminal. One of the motor-generator sets is in the background.

the shafts will not offer ready avenues of escape for the cold air when the doors of a refrigerated compartment are open. In fact, the arrangement is such that no elevator can be moved from a cold-storage floor until the compartment doors are closed. There are four high-speed elevators that are operated by a well-known type of micro-drive. This up-to-date plant was erected and ready to start running in the course of twelve months.

There is a railroad siding adjacent to each side of the plant; and ample platform space is available for both trucks and railroad cars so that loading or unloading can be carried on continuously. Seventy-two cars can be spotted along each side of the platform at a time; and in the associate terminal yard there is room enough to accommodate a total of 360 refrigerator cars.

So much for the general purpose and nature of this big and up-to-date terminal for handling perishable foodstuffs. Now let us briefly describe the essential features of the refrigerating machinery counted upon to keep the different compartments of the warehouse at the required temperatures. Looking forward to the time, in the near future, when the storage space will amount to 2,600,000 cubic feet, the builders of the plant have installed three ammonia compressors. These compressors are called upon to operate against back pressures of 3 pounds and 20 pounds. At a 3-pound back pressure each machine will have a refrigerating capacity of about 85 tons; and at a back pressure of 20 pounds, each machine will be capable of delivering the refrigerating equivalent of 165 tons. The three machines are identical, and are of the well-known PRE-2A type manufactured by the Ingersoll-Rand Company. That is to say, they have ammonia cylinders, respectively of 15 and 10½ inches, with a common stroke of 16 inches. They are driven by General Electric synchronous motors.

The ammonia compressors are directly connected with Vogt horizontal, multipass brine coolers. These coolers are of the shell-and-tube type. Each of the shells is 52 inches in diameter and 18 feet long, and each cooler contains 286 tubes 2 inches in diameter. There are two brine coolers—each provided with one ammonia accumulator or suction separator—on every cold-storage floor. The purpose of these units is to catch any liquid ammonia in the lines and to prevent its return to the compressors. Each accumulator is 32 inches in diameter and 66 inches long, and is fitted with a spiral coil—containing 115 feet of 2-inch, extra-heavy, wrought-iron pipe—through which the ammonia liquid from the receivers passes before entering the brine coolers. The temperature of the ammonia liquid is considerably reduced by the lower temperature of the return gas from the brine coolers, thereby increasing its refrigerating value per pound circulated.

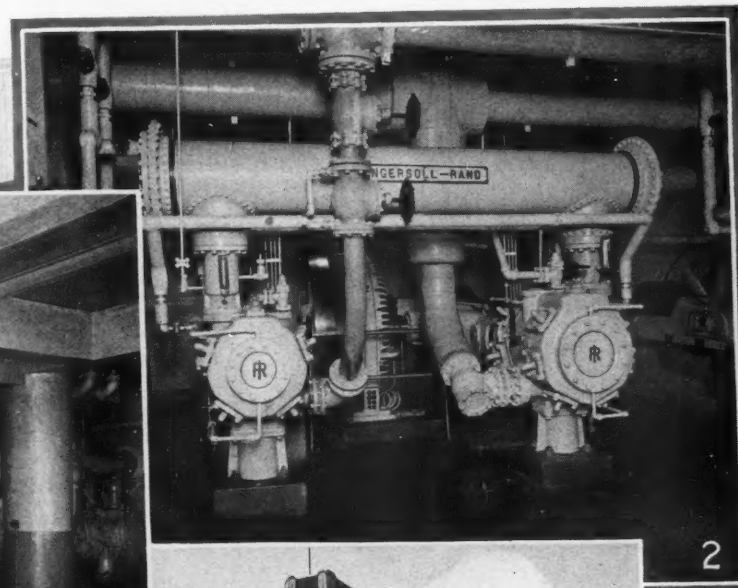
The condensers are of the Vogt 7-pass multitube type. There are four stands of these condensers, and each is six pipes high. The outgoing brine is delivered to the pipes of the circulating system at a temperature of 18½° F. below zero; and the returning brine is 14° below zero. These condensers embody the latest improvements, and are notably economical in water consumption. The high rate of heat transmission is due to the velocity of flow and to the manner in which the cooling water is distributed.

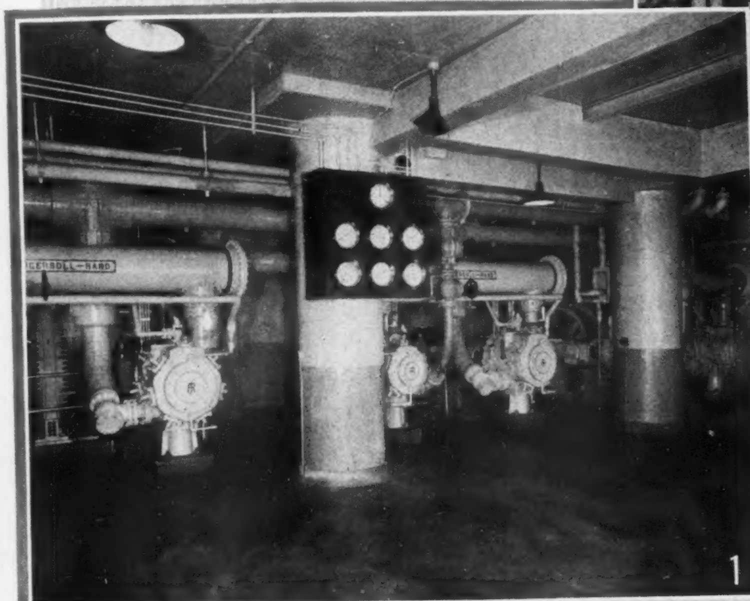
Vertical water headers are arranged at both ends of each condenser so as to provide satisfactory distribution to the ends of the 8-inch outside pipes. Within each 8-inch pipe the water is conducted serially through seven 2-inch tubes by means of the baffled headers, and is discharged at the opposite end. The cooling water enters all caps simultaneously, and is confined within the tubes long enough for the maximum heat transfer to take place. Each pipe is virtually an individual condenser, with its own independent supply of fresh cooling water. These condensers can be cleaned while in service by merely removing the semi-steel caps at the ends of the pipes. Because of their compactness, these condensers are economical in the use of floor space.

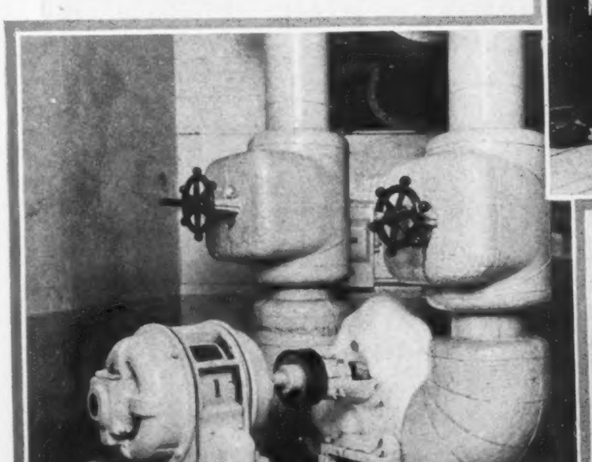
Suspended from the ceiling, adjacent to the ammonia condensers, is a 32x66-inch vertical oil trap. This trap separates all particles of oil that may be in the discharged gas and materially assists in keeping clean the surfaces of the ammonia condensers and the evaporating system. Beneath the condensers is the ammonia receiver. It is 28 inches in diameter by 20 feet long; and is equipped with self-closing gage valves, an oil drain, and purge connections. A Hill non-condensable gas separator is connected to the receiver and the ammonia condensers.

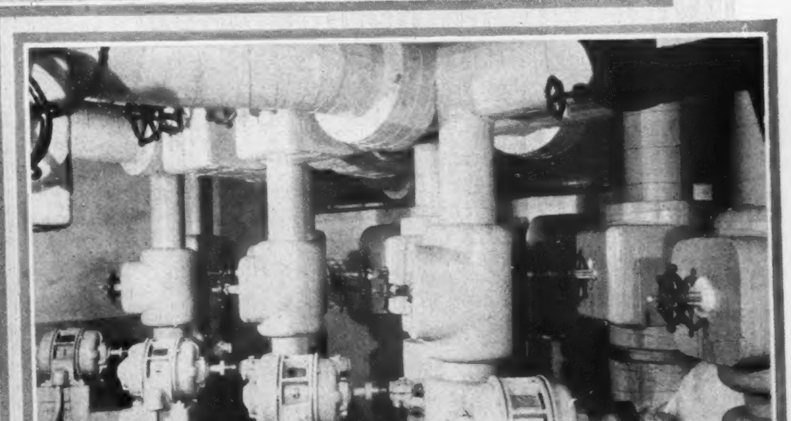
The cold brine, upon leaving the coolers, is fed to the rooms through risers. The brine-return lines terminate in the elevator house on the roof, where they enter balancing tanks. The use of balancing tanks, which are equipped with gage columns and air vents, insures the system being fully charged with brine and free of air. From the balancing tanks the warmed brine passes directly to the coolers.

Auction sales building, at left, and cold-storage building, at right, of the Baltimore & Ohio-Reading Perishable Products Terminal.

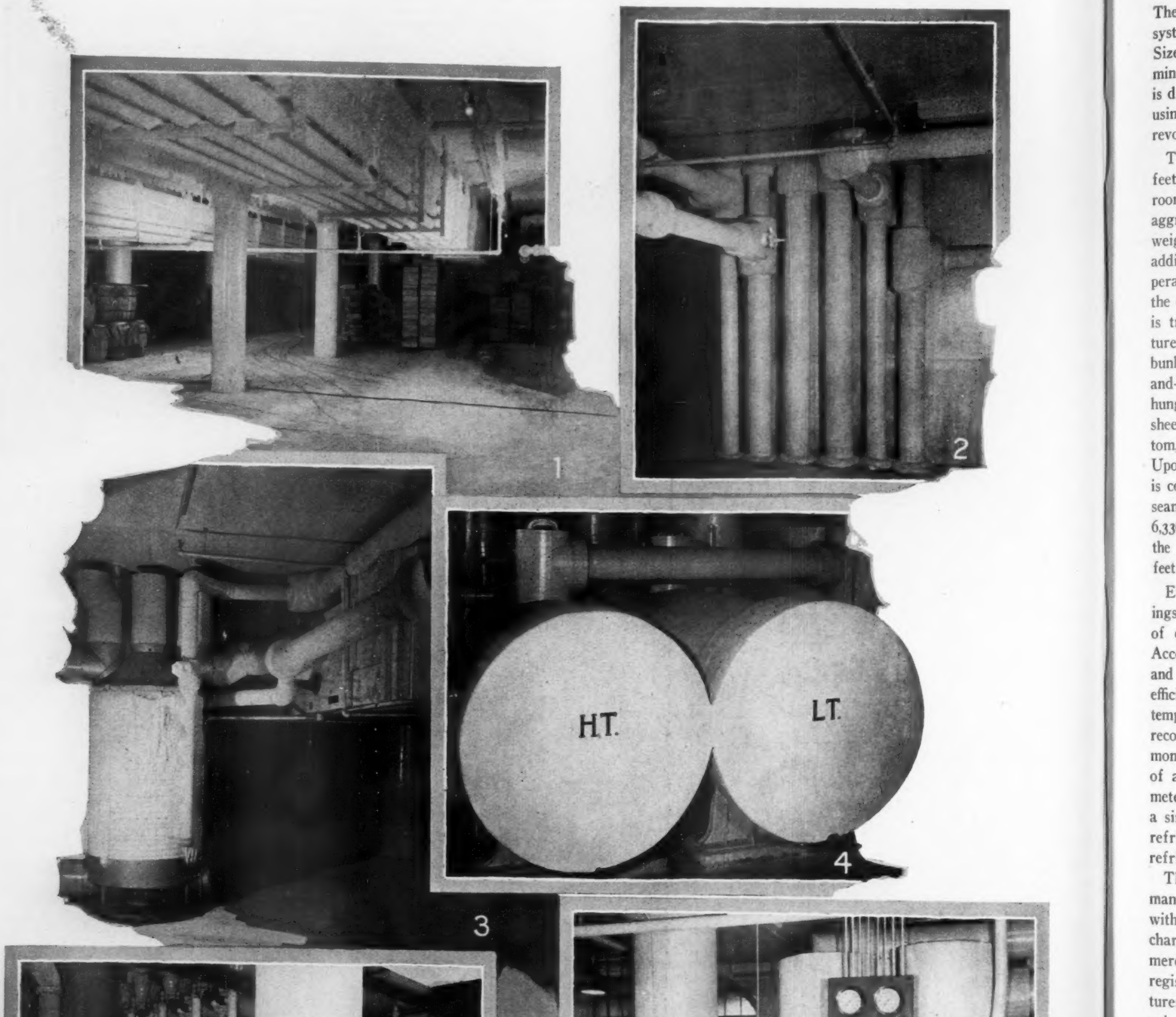








1—Three large PRE-2A ammonia compressors that have sufficient refrigerating capacity to take care of 2,600,000 cubic feet of cold-storage space.
2—Close-up of one of the big electrically driven ammonia compressors.
3—The cold-storage plant of the Baltimore & Ohio-Reading Perishable Products Terminal.
4—One of the Cameron LV brine pumps, capable of handling 500 gallons per minute.
5—The four 4-inch Cameron LV brine pumps that distribute the brine throughout the cold-storage compartments. Each pump makes 1,200 revolutions a minute and is driven by a 20-hp. General Electric synchronous motor.



1—One of the cold-storage rooms partly filled with perishable products.
2—Brine risers of this type are installed on each of the cold-storage floors of the terminal.
3—Dehumidifier used in conditioning the ventilating air delivered to the cold-storage spaces by the Moore system, with which the plant is equipped.
4—Brine coolers mounted in the engine room of the terminal.
5—Vogt multitube condenser, ammonia receiver, and 8-inch oil trap forming essential parts of the refrigerating equipment.
6—Brine manometers, pen recorders, brine pressure gages, and ammonia recorders forming features of the temperature-control station for the entire plant.

The brine is distributed through the circulating system by four Cameron pumps—Type LV, Size No. 4—capable of handling 50 gallons a minute against a head of 80 feet. Each pump is driven by a General Electric motor of 20 hp., using current of 440 volts, and making 750 revolutions per minute.

The freezer rooms are approximately 54x86 feet, with ceilings 11½ feet high. In these rooms the coils are arranged in three banks, aggregating 6,300 feet of 2-inch, standard-weight, wrought-iron pipe. On each floor, in addition to the freezer room, are two high-temperature rooms. One is about 90x86 feet, while the other is a little more than half as large and is triangular in shape. In both high-temperature rooms are installed bunker coils. The bunkers are well constructed of ⅞-inch tongue-and-groove yellow pine, laid on cross pieces hung from coil supports. A layer of 2-inch sheet cork, with waterproof paper top and bottom, forms the insulation for the bunker floors. Upon this is a course of ⅞-inch ship-lap, which is covered with galvanized iron having soldered seams. The bunkers in the large room contain 6,336 feet of 2-inch, wrought-iron pipe, while the bunkers in the small room contain 4,080 feet of the same kind of piping.

Every facility for obtaining accurate readings at a glance—either of brine, ammonia, or of electrical consumption—has been provided. Accordingly, correct logs are easily obtained; and the plant can be functioned at the highest efficiency. Both low-temperature and high-temperature brine coolers are equipped with recording indicators for measuring the ammonia. With these indicators giving the pounds of ammonia circulated and with the electrical meters registering the power consumed, it is a simple matter to determine the total tons of refrigeration and the horsepower per ton of refrigeration.

The brine from each cooler is measured by a manometer equipped with a Venturi tube and with two gages which give the suction and discharge pressures. There is also a bi-record, mercury-actuated recording thermometer for registering the brine inlet and outlet temperatures. A manometer is likewise used for measuring the water going to the ammonia condensers and intercoolers. Each of the three intercoolers has a gage, which indicates the pressure difference between the first and the second stages of compression in the ammonia compressors. All brine, water, and ammonia systems are equipped with Tycos thermometers. The ammonia system is provided with the necessary safety valves; and each compressor cylinder has a safety valve that relieves into the suction side of the machine. There is a single large, well-arranged switchboard from which are controlled the ammonia compressors, the brine pumps, the motor-generator sets that provide direct current for exciting the motors of the three ammonia compressors, and the compressor that furnishes air for the dry automatic sprinkler system. The entire installation of the refrigerating equipment was made by the Henry Vogt Machine Company; and many of the preceding details of the apparatus were furnished by a representative of that company.

One of the loading platforms.

Having provided these terminal facilities at an outlay of $4,000,000, the two responsible railroads then cast about for an experienced company to run the plant. This they found in the Quaker City Cold Storage Company, to whom the property was leased. This well-known concern has been operating for some years other plants at different points in Philadelphia. The operating manager of the various plants of the Quaker City Cold Storage Company is Mr. A. F. Saunders.

NEW COURSE IN HEAT ENGINEERING

BEGINNING with the new term, the Carnegie Institute of Technology will give a course in heat engineering that is especially planned to meet the increasing demand for engineers trained in fuel conservation. The new course will be under the direction of Prof. W. Trinks, who is a national authority on furnace, combustion, and fuel problems.

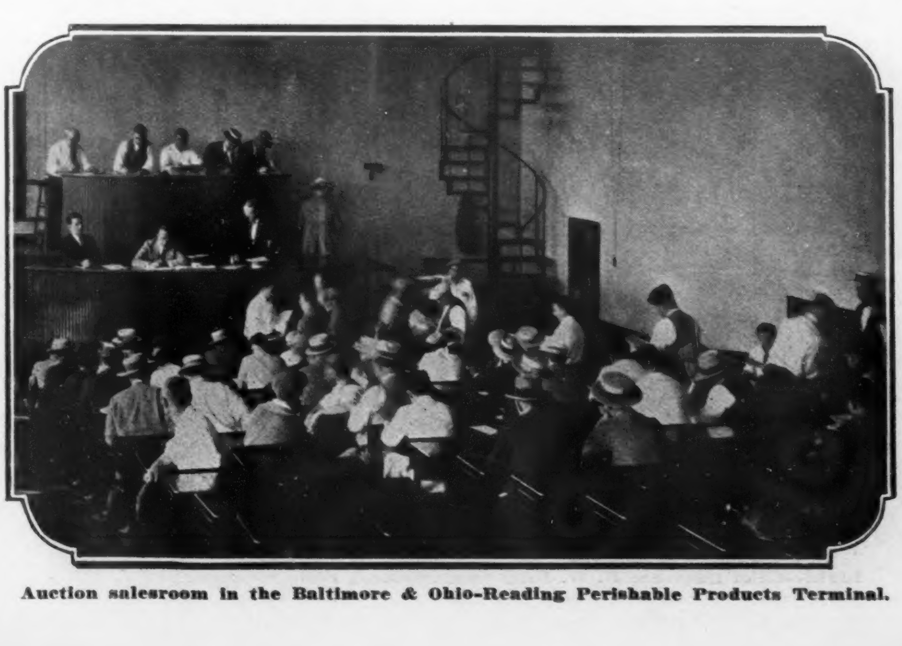
To assist in the work of instruction, as well as for experimental purposes, there has been installed in one of the laboratories of the Institute a combustion tunnel. This tunnel is said to be the only one of its kind in any college or university in the United States.

AUTOMATIC TIMEKEEPER FOR RACETRACK

AN automatic timekeeper that will remove all element of doubt as to the winner of a race was successfully tried this summer at a meet at Cape Town, South Africa. The apparatus—the invention of a wireless expert of that city—is operated by a ray of light, one-fifth inch in diameter, that emanates from a lamp in the judge's box.

This ray is focused across the course and on to a selenium cell fixed in the winning post. Anything crossing the line of the ray prevents the light from reaching the cell; and the exact moment of the stoppage is registered on a clock. This clock is a large affair, 9 feet high; but the actual timekeeper is a pocket chronometer attached to a miniature wireless transmitter. The start of the race, etc., are controlled by a 2-valve amplifier.

It has been estimated by Director F. C. Houghten, of the American Society of Heating & Ventilating Engineers, that more than 5,000,000,000,000 cubic feet of air would have to be pumped daily if the moving-picture houses in the United States were kept properly ventilated.



Auction salesroom in the Baltimore & Ohio-Reading Perishable Products Terminal.

Vast Pipe-Line System In America

Description of One of the Hundreds of Pumping Plants That Send Crude Oil Through 90,000 Miles of Piping

By ALLEN S. PARK

ORDINARILY, when we speak of the transportation of commodities, we refer to their haulage by rail, by highway, or by water. When the commodity happens to be crude oil, however, another means of transportation may be and is, in fact, very often concerned. Oil has an advantage over other materials that are moved from place to place in large quantities. Being fluid, it can be handled in pipe lines.

During 1926, according to the *Oil & Gas Journal*, a total volume of 1,633,802,000 barrels of crude oil was moved within or from the United States by various means, as follows: By pipe lines, 756,000,000 barrels; by tank ships from the Gulf of Mexico to Atlantic coast ports, 113,000,000 barrels; by tank ships coastwise from California to eastern ports, 28,000,000 barrels; by tank ships to foreign ports, 111,802,000 barrels; by tank cars, 402,000,000 barrels; and by tank trucks, 223,000,000 barrels.

As the aggregate volume thus accounted for is approximately twice the 1926 production of petroleum, it is evident that a great bulk of it was handled two or more times. To illustrate how this may come about, let us picture a new oil field in Texas. Pipe lines are not laid until the new field has proved extensive enough to insure a considerable output of oil for transportation. In the meantime, the oil that comes from the ground must be conveyed to refineries. It may be hauled in tank trucks to a railroad and transferred to tank cars for shipment to a pipe line, which may deliver it to a tank ship at a Gulf port. The tanker may then take it to a refinery on the Atlantic coast or in some foreign port. Under such circumstances, the same oil is handled four times, and each time by a different agency. It can thus be seen that there is no way of determining, from the available figures, the exact proportion of crude-oil movement in pipe lines. Generally, however, wherever pipe lines are at hand they are utilized because of the economy they offer.

The investment in pipe lines and in structures and machinery incidental to their operation totaled $800,000,000 in 1926, and probably amounts to some millions more than that today. All told, there are 90,000 miles of pipe line in use in the United States—enough to encircle the globe nearly four times. This network of piping is capable of holding 15,750,000 barrels of crude oil.

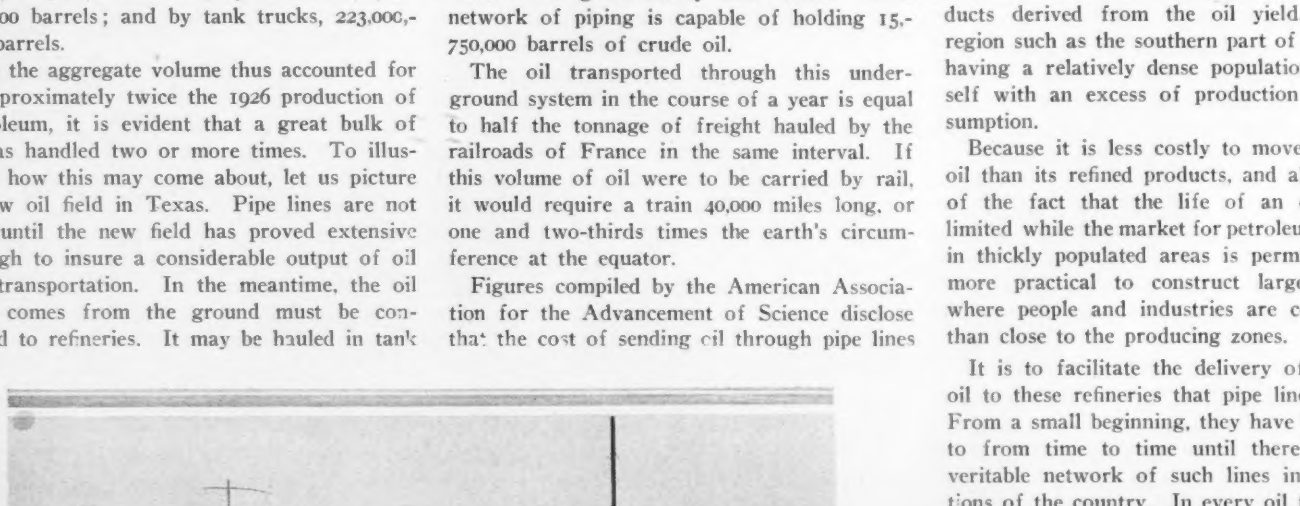
The oil transported through this underground system in the course of a year is equal to half the tonnage of freight hauled by the railroads of France in the same interval. If this volume of oil were to be carried by rail, it would require a train 40,000 miles long, or one and two-thirds times the earth's circumference at the equator.

Figures compiled by the American Association for the Advancement of Science disclose that the cost of sending oil through pipe lines ranges from 4 to 10 cents per mile per 100 barrels. This is about one-tenth the cost of rail-freight transportation. The reason for this economy is that only the oil is moved—there is no dead weight in cars. Transportation through pipe lines is continuous, 24 hours a day; and to operate a given mileage of line only a small force is required when compared to the personnel needed to move the same tonnage an equal distance by railroad.

When an oil field is opened up and developed, refinery facilities are established near by of sufficient capacity to supply the contiguous trade area with the various products obtained from the oil. Few oil-producing sections can absorb their entire output, hence the surplus is marketed elsewhere. For example, Wyoming contains an abundance of producing fields; but it is such a sparsely settled state that it can use only a small fraction of all the products derived from the oil yield. Even a region such as the southern part of California, having a relatively dense population, finds itself with an excess of production over consumption.

Because it is less costly to move the crude oil than its refined products, and also because of the fact that the life of an oil field is limited while the market for petroleum products in thickly populated areas is permanent, it is more practical to construct large refineries where people and industries are concentrated than close to the producing zones.

It is to facilitate the delivery of the crude oil to these refineries that pipe lines are laid. From a small beginning, they have been added to from time to time until there is now a veritable network of such lines in some sections of the country. In every oil field of any size there are numerous small branch lines



Left—The Owensboro pump station of the Illinois Pipe Line Company. The steel standards of the radio, used by the company in the transaction of business, rise to a height of 150 feet. Right—Chief Engineer H. W. Mills transcribing a radio message.

which collect the oil from the wells and convey it to bigger lines. These small lines are known as gathering lines, while the larger ones—which extend from the fields to the refineries—are classed as trunk lines. Some of these trunk lines are of considerable length. For many years, oil produced in Texas has been piped to Bayonne, N. J., for refining—a movement of more than 2,000 miles. Similarly, a great deal of the petroleum originating in Wyoming is sent to refineries in the vicinity of Kansas City.

The transportation of oil by pipe lines is a separate phase of the oil industry. Most of the lines are owned and operated by companies that are neither producers nor refiners. Some of them own thousands of miles of line having a valuation of many millions of dollars. A list of the larger ones would include such pipe-line companies as the Humble, the Prairie, the Sinclair, the Tuscarora, the Illinois, and the Indiana, as well as many others. Most of these trunk lines are interconnected, making it possible to continue the transportation of oil beyond the terminal of any particular system, just as through freight is routed via connecting railroads.

A pipe-line company operates after the manner of a railroad. It is a common carrier, and is subject to the rules and regulations of the Interstate Commerce Commission if its lines cross any state border. It must file its tariffs with that body; and the rates imposed apply alike to all users of the lines. In general, the rates are twofold in character. One is the gathering charge: the fee received for collecting the oil from the various wells and for sending it to a trunk line. The other is the amount charged for trunk-line transportation to the refinery. Oil other than that owned by a company having refinery facilities usually is sold at the well. The purchaser, generally a refiner, then contracts for the delivery of the oil with the pipe-line company serving that district.

Pipe lines are built along direct routes between points of production and of refinement, or between producing fields and existing pipe lines. Rights of way are first secured. The lines are commonly placed about 12 or 14 inches below the ground. This removes them from the effects of temperature changes and also renders them non-obstructive to farming activities and to surface operations. The piping in common use is of wrought iron, and comes in 22-foot lengths connected by screw joints. Recently, however, some steel pipe has been utilized, and lines have been constructed of 40-foot sections with welded joints. The lines are patrolled regularly by walkers who locate and report leaks. While the piping corrodes rather rapidly, its life is usually equal to that of the field it serves.

A picturesque autumnal scene in Old Kentucky.

The trunk lines are of various sizes, according to the amount of oil to be moved through them. In places, several pipe lines are laid along the same right of way, just as two or more railroad tracks run parallel to one another. Where topographical conditions are favorable, the oil flows by gravity. For the most part, however, it has to be pumped—the frequency of the necessary pump stations and the capacities depending upon the volume of oil to be handled and upon the topography of the country traversed by the lines. The average rate of flow of the oil within the piping is 4 miles per hour. At this speed, an 8-inch pipe line—which is the prevailing size for trunk systems—will carry approximately 31,500 barrels per 24-hour day. A 6-inch line will take care of about 17,700 barrels within the same period and at the same rate of flow.

By spacing pump stations closer together or by raising the pressure exerted by the pumps, the rate of flow will be increased. On a trunk line where gravity does not materially aid the movement, stations are located on an average of every 40 miles. These stations utilize various types of equipment—the machines differing in size according to the amount of work they are called upon to do. Small pumps at the wells are often operated by power furnished by the well equipment, for which the well owner is paid on the basis of a stipulated sum for each barrel pumped.

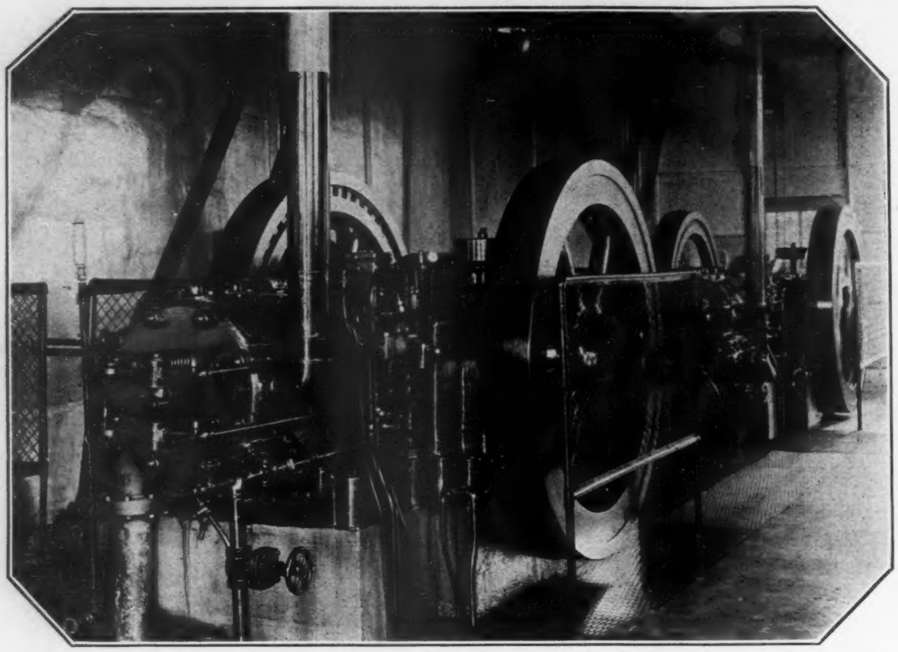
Storage tanks having capacities of from 10,000 to 55,000 barrels each are provided at every pumping station. In order that a close check may be kept on the movement of the oil, it is pumped to and from these tanks—that is to say, the stream is broken at each station. The inflowing oil goes to one storage tank, while that pumped out and on to the next station is drawn from another tank.

At each station are pressure gages. Any decrease on the line as revealed by these indicators serves to give immediate information as to leakages. In such a situation, the engineer on duty at once communicates with the next station ahead and with the superintendent of the line. By reversing the engines, suction is then created to draw the oil in the broken section back and away from the leak. Line dispatchers are sent to locate the leak disclosed by a flow of oil to the ground surface. Repair gangs go out as soon as they can be mobilized. The existence of the storage tanks makes it possible for all sections of the line other than the one affected by the leak to continue pumping while repairs are under way.

Formerly, trunk-line pump stations were operated by steam. The cheapest fuel available—wood, coal, oil, or gas—was burned under the boilers. But since the development of the internal-combustion oil engine, practically all pump stations have installed units of this type. In addition to their high efficiency, they have reduced pumping costs to a fraction of what they once were. They do away entirely with boilers, thus saving on building construction and equipment costs; they eliminate the need for firemen and for ash removers; and they conserve in various other ways. Moreover, they use the fuel that is being transported through the pipe lines.

To give the reader a fuller understanding of the equipment of a modern pump station, a brief description of a plant will be in order. The

A lovely section of Kingfisher Lake, near Owensboro.



Two 17x19-inch PO oil engines provide economical and dependable power for the operation of the pumping plant.

station in question belongs to the system of the Illinois Pipe Line Company, and is an integral part of a line that delivers oil from points in Kentucky to the Indian Refining Company's plant at Lawrenceville, Ill. The line was built by the last-mentioned company, being sold to the present owners in the fall of 1926.

The pipe line extends from Bowling Green, Ky., to Lawrenceville, and is 142 miles long. Some of the oil originates around Bowling Green, and is carried into the pump station at that point by various feeder lines. It is then pumped to a station at Owensboro, Ky., 65 miles distant. This stretch, which is a gathering line, consists of 22 miles of 4-inch and 43 miles of 6-inch piping. The section of the line from Owensboro to Lawrenceville, a distance of 77 miles, is a trunk line and consists of 6-inch pipe throughout. In addition to the oil received at Owensboro from Bowling Green, another feeder line comes in from Whitesville, about 20 miles away, at which point local production is concentrated by gravity lines. There also is some shipment of oil to the Owensboro station in tank cars.

The oil that is thus gathered at Owensboro aggregates about 5,000 barrels a day, which is just about sufficient to keep the pump station operating steadily without taxing the capacity of its equipment. It should be noted, in this connection, that the pumping distance is relatively great. If the amount of oil handled were to be increased to any marked extent it would become necessary to provide another station at some intermediate point. As it is, the long relay of pumping reduces the speed at which the oil travels through the line, and consequently lowers the line's daily capacity.

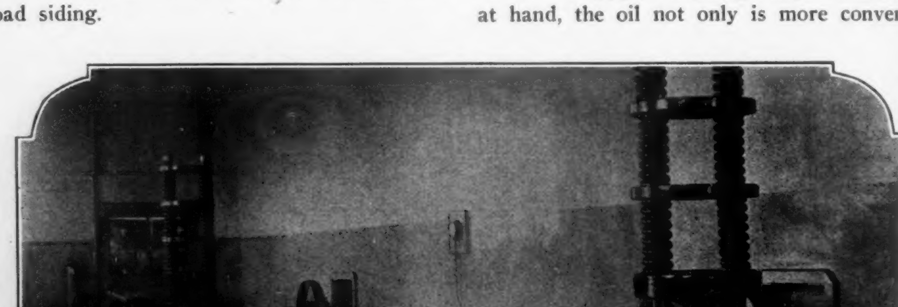
The Owensboro station, like most pipe-line pumping plants, was designed for continuous service, and is, accordingly, equipped with duplicate sets of pumps and driving engines. In practice, one set is operated for a week and is then supplanted for a week by the other set. This duplication makes it possible to keep the equipment in proper working condition at all times so that there will be no occasion for shutting down the plant as a result of failure of the machinery.

The pumping units at the Owensboro plant are of the horizontal, double-acting, reciprocating piston type, made by the Goulds Manufacturing Company, of Seneca Falls, N. Y. The cylinders are 4½x12 inches. They operate against a pressure of 475 pounds to the square inch. There is also a 7x12-inch horizontal-type pump which is used exclusively for unloading tank cars at the near-by railroad siding.

The power is supplied by two Ingersoll-Rand Type PO 17x19-inch oil engines. The pumping units are in an adjoining room—the power being transmitted to them by shafts extending through the wall. By means of a belt, from a pulley on this shaft, the engines also drive an overhead power shaft. From this shaft a belt operates a 5-kw. generator, which furnishes current for lights and for a small motor-generator set used to supply power for a radio station that will be mentioned presently. A small air compressor also is driven from the shafting. This compressor produces high-pressure air for starting the oil-engine units. This arrangement does away with the necessity of operating the compressor with gasoline-engine power, although such an engine is available in case of emergency. The generator and air-compressor units are installed in duplicate, carrying out the general policy of the plant. The pump employed for unloading oil from tank cars is not direct connected to the oil engines. It is driven by a belt from the shaft connecting one of the engines with one of the pumps.

The PO units have been in service five years and have thoroughly proved the economy of correctly designed, well-built internal-combustion oil engines. They are of the 4-cycle, solid-fuel-injection type which operates on simple principles and which is especially high in mechanical and thermal efficiencies. Figures covering one month of service, taken at random and declared by officials of the company to be representative, show that one or the other of the engines was running 713 hours out of the 720 hours of elapsed time. The fuel-oil consumption was 2,527.14 gallons—an average of 84.96 gallons per 24-hour day, or 3.54 gallons per hour.

The oil utilized is that which is pumped through the line. It is an asphalt-base petroleum of 34.5°, Baumé, gravity. Being right at hand, the oil not only is more convenient



Double-acting, reciprocating pumps force the crude oil more than 75 miles through an 8-inch pipe line.

The start of an 80,000-barrel, steel oil tank. With these air-operated tools it is possible to ream 10,000 holes in a day and to drive more than 2,000 three-eighth-inch cold rivets.

for use but also costs less than the fuel ordinarily burned in this type of engine. As the company is in a position to get its oil at the minimum price, the greatest possible economies are thus obtainable. The combined cost of fuel and lubricating oils is $3.53 a day, or 14.7 cents an hour.

One of the interesting features of the plant is the radio station. Once every hour the amount of oil pumped from and received by the various stations on the line is checked. Most companies do this by telephone or by telegraph; but on a few sections of the pipe line, of which this is one, the wireless has been adopted as the means of communication. Measurement of the oil is effected by gage readings on tanks. Careful and frequent checking of these readings between stations makes it possible to learn immediately if there is a break in the line or any other failure in the system.

The radio station at the Owensboro plant is of 1-kw. power—the current being furnished by the motor-generator set previously mentioned. Two 150-foot steel masts carry the aerial. The sending is done in telegraphic code. In addition to checking the pipe-line run, the radio serves to send general messages from the company's field stations and offices to the general offices at Findlay, Ohio. These radio communications go as far as the district offices at Martinsville, Ill., from which point they are relayed to Findlay over the company's own wires.

The radio station is licensed by the Government as a commercial sending station, and all operators must hold licenses. Because of the mechanical simplicity of the pumping-plant equipment it is the practice to employ as engineers men who are qualified radio operators, and to give them the training that will fit them for the work of operating the pumping-plant machinery.

ART OF HARDENING COPPER NOT A MYSTERY

IT has been a tradition that the ancients were able to harden copper and to give to implements fashioned of that metal fine and fairly lasting cutting edges. Some modern metallurgists, on the other hand, have frequently declared that the ancients were unable to do anything of the kind. Recently, an issue of *Research Narratives,* was devoted to hardened copper; and the topic was treated in the spirit of a long-lost art recovered. The following text is taken *verbatim* from the bulletin mentioned, and will probably prove of interest to many of our readers:

"There exists, on the part of those not intimately connected with the working of copper, a belief that the ancients had a method of hardening that metal, with which art we today are not familiar. The fact of the matter is that our present-day metallurgists not only understand how the ancients hardened their copper and bronze but also know how to produce copper and bronze products that are even harder than those left to us and which represent the evidence of the so-called lost art of hardening copper.

"Cutting edges developed on swords, daggers, knives and other implements by the ancients were obtained by hammering the metal, or, in other words, cold working. Those old metalworkers not only hand-hammered their copper implements but also used the same means to harden their bronze articles. The heating of many of these products in open fires resulted in the formation of considerable copper oxide, which alloyed with the copper and hardened it. One of the most common mistakes of persons claiming to have rediscovered 'the lost art of hardening copper' is to heat it in a forge and in this way to saturate it with copper oxide, which combines with the copper to form a much harder and a much more brittle product.

"There are really two methods of hardening copper that are regularly practiced nowadays, just as they were centuries ago. One consists in alloying the copper with some other metal, or several other metals—such as zinc, tin, nickel, cadmium, chromium, cobalt, silicon, aluminum, iron, beryllium, and arsenic. The second method consists in cold working the metal or copper alloy. In fact, it is possible to work the metal to such a stage of hardness that a slight amount of additional work will cause it to break. The explanation of all copper hardening may be attributed to one of these methods, or a combination of them. Microphotographs of an ancient copper spearhead indicated that it was extremely hard and

The oil-engine units operate the pumps by means of shafts extending through the wall into the pump room. They also drive line shafting from which a small generator is operated by belt.

that this hardness apparently had been obtained by cold working.

"Copper scissors, knives, and other cutting tools may be obtained. Unless, however, a special reason exists for their use, they offer no advantages over tools made from steel. Occasionally, it becomes necessary to use copper or bronze tools, such as knives. Around a powder plant, for instance, where sparks must be avoided, bronze knives are almost essential.

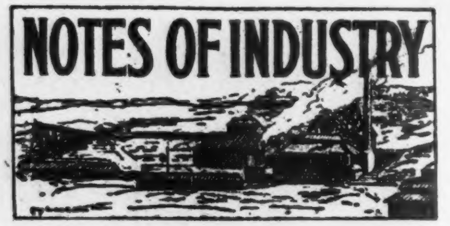
"The actual hardness of annealed commercial copper, as determined by the Brinell machine, is from 40 to 50. The hardness of cold-worked pure copper probably does not exceed 120 Brinell. The hardness of copper that has been alloyed with some other metal, or a number of metals, rarely exceeds 250 Brinell, although a maximum hardness just over 300 has been attained. As a basis of comparison, it may be stated that the Brinell hardness of very 'soft' iron is around 80 and of steel in common cutlery, such as a finished pocket knife, about 420 Brinell.

"Not only do many persons spend a short while trying to rediscover an art that never was lost, but some of them devote a whole lifetime to this effort. The tragedy, or rather the denouement, occurs when they have evolved a hard copper. They next attempt to find some use for it and then learn that, unless it has some special properties, no market exists.

"Copper wire, hard drawn, has a tensile strength of about 65,000 pounds per square inch, and an elongation in 10 inches of about one per cent., with a conductivity of about 97 per cent. This affords some basis on which to work when endeavoring to develop the hardening of copper. If, for example, it were possible to harden copper so that the tensile strength were materially increased above that just stated, without reducing the conductivity, a worth-while discovery would be made.

"Some recent methods of hardening copper by alloying have come about as near to actually 'tempering' copper as would seem possible. In these methods the metal silicon plays a most important part because it forms silicides with other metals which, in turn, form eutectics with the copper. The deoxidizing effect that silicon by itself exerts plays no unimportant part in finally allowing the metal to be worked and, by heat treatment, to develop a high strength with a relatively high conductivity. This latter, however, is considerably below that of pure copper, and second only—speaking of alloys from the standpoint of both strength and conductivity—to those of copper and cadmium. Alloys of copper with cadmium give, for a stated conductivity, higher strengths than those with silicon."

According to George McCormick, general superintendent of motive power for the Southern Pacific, the energy released by one pound of coal burning under the boiler of a modern locomotive is sufficient to carry a human being nearly 100 miles. Expressed differently, 2½ ounces of coal, or its equivalent in fuel oil, will generate enough steam power to move one ton one mile.



Familiar as most of us are with radio equipment, it might surprise some of us to learn that vacuum tubes are now built for the dispatching of wireless waves that are 7½ feet high, having a diameter thicker than a man's arm, and containing a grid 3 feet 5 inches long. Tubes of this size require current to operate them that would be sufficient to energize 2,500 lamps of 40-watt capacity.

A sample of gold wire drawn so fine that 3,500 yards weigh only 1 ounce attracted much attention at an exhibition of gold and silver wire drawers held not long ago in England.

Work on the Moji-Shimonoseki Straits railway tunnel, which was held up on account of the devastating earthquake of several years ago, is to be begun in 1928 by the Japanese Government. The tunnel will do away with the ferry service that now connects Kyusha and points in Honshu and that is so often interrupted by storms for 24 hours at a time. The bore will be constructed at a cost of $10,000,000; and 3,000 men will be engaged on the undertaking.

Grecian emery is said to be the hardest known form of the mineral, and has been mined for centuries on a number of islands in the Aegean Sea.

Rich deposits of aluminum clay and iron ore have been discovered, according to *Commerce Reports,* in the center of a large mountain situated between Onundarfiord and Sugundafiord, Iceland. The aluminum deposit consists of a stratum 6½ feet thick, 2.2 miles wide, and 4.4 miles long, and lies about 984 feet above sea level. Samples of the ore sent to Scotland for analysis were found to carry from 35 to 50 per cent. of aluminum oxide. It is estimated that the deposit contains hundreds of millions of tons of aluminum-bearing ore.

The Columbia, which is one of our greatest rivers, contains at least one-third of all the water power available in the United States. It drains a basin of 259,000 square miles that covers sections of seven states and extends into Canada. The volume of water carried annually by the Columbia River system represents a national asset of immense economic value.

The Australian Federal Government has appropriated a sum of about $500,000 that is to be spent in prospecting for oil. That country is now entirely dependent on foreign sources of supply, as no oil-bearing sands have so far been discovered there.

The number of new applications for asbestos fiber that is too short for spinning is on the increase. We are told that it has proved to be a good filler for several kinds of paint; that is serves to make a heat-insulating paste and what is known as "stone-wood"; and that, when combined with gypsum, it can be turned into a mold lining for foundry work.

During the past six or seven years, the number of wireless patents in the United States have multiplied to such an extent that that department of the Patent Office has had to be doubled. Today, an average of 125 applications are made each month as against 60 in 1920.

The total capacity of water wheels and turbines in hydro-electric plants in the United States at the beginning of 1927 was 11,721,000 hp., an increase of 544,000 hp. over the preceding year.

Activities on the site of the corundum claims in the Rusape district of South Africa are attracting the attention of mining engineers. It is reported that an extensive deposit has been traced from Inyazura to Marandellas.

What is said to be the longest continuous stretch of concrete roadway in the world has just been completed between White Bear and Duluth, Minn. Throughout its length of 137 miles, this pavement passes through 29 towns and villages.

South Africa may become an important producer of radio-active ores, as the existence of such minerals in the Pietersburg district of the northern Transvaal has been confirmed by qualified analysts. The samples tested consisted of titaniferous magnetite hornblende, biotite quartz, and feldspar. Several of the specimens were found to be similar to the pitchblende of the Belgian Kongo, and unusually rich in uranium. Exploratory work is now in progress to determine the extent of the deposits.

The statement has been made by the Bureau of Public Roads that, except for highways in the vicinity of large cities and much-traveled trunk lines, a minimum width of 18 feet is sufficient for main roads to take care of the present traffic and of that for some years to come.

This is the Age of Riveted Steel is the title of a motion-picture film that visualizes the story of the inconspicuous but dependable rivet and that illustrates in detail the production of rivets and their use in the erection of steel buildings and bridges, in the manufacture of railroad equipment, automobiles, boilers, etc., etc. This moving picture can be borrowed from the Hanna Engineering Works, 1765 Elston Avenue, Chicago, Ill., by any technical society, club, university, school, or other organization interested in the art of riveting. The film is of standard width, and is non-inflammable.

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EDITORIALS

HIGHWAY CASUALTIES CAN BE REDUCED

"EVERY forty-one seconds some one is either killed or injured in highway accidents in the United States. During the five years ending with 1927, the staggering total of approximately 3,446,370 persons was reported injured and 114,879 killed in traffic calamities, most of which were avoidable. The annual casualty toll of highway accidents is more than twice as great as the entire number suffered by the nation's forces in the World War."

In the foregoing manner, CHARLES M. UPHAM, director of the American Road Builders' Association, has crystallized in a recent paper the conditions that are costing the pedestrian and the motor-vehicle driver, in this country, so dearly. In the face of these facts and figures it is manifest that there is urgent need of remedial or corrective action of one sort or another.

Statistical research has revealed that there is an hour at the close of each busy day that levies the heaviest toll on life and limb. This is between five and six o'clock when the haste and the fatigue of homeward-bound persons invite confusion and carelessness that lead to accidents. It seems that accidents involve pedestrians oftener than they do collisions between cars; and less than 5 per cent. of all accidents are due to faulty mechanisms of vehicles or to improperly designed roads and streets. The human machine—mainly because of carelessness and incompetency—is responsible for the remaining 95 per cent. of the accident total.

Investigation has disclosed that children between the ages of six and twelve are the principal sufferers among the juvenile victims; and we are told that drastic legislation is exercising an increasingly effective curb upon the recklessness of intoxicated drivers. All told, however, the economic loss from highway casualties is estimated at $50,000,000 a month, or $600,000,000 a year!

The ultimate objectives of this general movement for highway safety, as enumerated by Mr. UPHAM, are: First, the education and the regulation of pedestrian traffic as well as motor-vehicle traffic; second, the adoption of a standard code of motor-vehicle laws in every state of the Union; third, education in safety and accident prevention; fourth, asking motorists to protect their machines by periodic adjustment and replacement; and, fifth, a comprehensive program of street widening and the elimination of grade crossings.

Surely, every encouragement should be given the American Road Builders' Association in its self-imposed task of public enlightenment in the cause of greater highway safety. There is a crying need for betterment.

WHY WEATHER CHANGES

MANY of us chronically find fault with the weather whenever it does not happen to suit our present plan of activities. And some of us, in the fullness of our self-sufficient wisdom are perfectly satisfied that substantial climatic changes have taken place in our accustomed environment between the days of our childhood and those of our maturity. Most of us forget, however, that our standards of comparison and our physical reactions to the weather have gradually altered in the meantime. Just the same, changes are continually taking place, but these changes become noticeable only over periods of time that are far too great for any single generation to realize.

An official of the United States Weather Bureau has recently enumerated the controlling factors that bear directly upon climatic changes. One is the radiation from the sun; another is the composition of the atmosphere which either permits or does not permit that radiation to reach the earth in its fullness; and, third, the presence or absence of mountains. These factors influence the amount of received heat, the measure of rainfall, and the direction of the winds that may or may not carry moisture or dust with them.

Moisture-laden clouds mean flowing streams and verdant hills and plains, while wind-blown sand may so change the complexion of the face of the earth by powdering it, so to speak, that solar heat would be reflected instead of absorbed by the soil—thus cooling the terrestrial atmosphere. A dark soil, on the other hand, would absorb the heat and induce a warmer climate.

Plainly, physical alterations must be of a radical character to bring about any marked modification of climate; and to reach effective proportions these alterations usually require ages. Unless we made a pretty bad guess, none of us would like to live long enough to see the outstanding consequence of any of these transformations.

GREAT DNIEPER PROJECT UNDERWAY

FROM time to time the daily press has contained references and more or less lengthy articles having to do with what is known as the Dnieper River Power Project—a scheme to dam the Dnieper River for the purpose of developing 350,000 horsepower. The magnificence of the project has made many people skeptical regarding its probable execution; but, apparently, the government in Russia is determined to carry the undertaking forward to completion within the next five years.

According to the *New York Times*—quoting the originator of the Dnieper project, a force of 2,500 workers is now engaged in excavating for the system of locks that will permit river traffic after the dam has been constructed. The erection of the dam will be underway before fall, so we are informed.

The engineering world will follow with interest the activities in connection with this gigantic task; and Americans will have particular reason for doing this because Colonel HUGH L. COOPER—intimately identified with a number of hydro-electric undertakings consummated and planned—is the chief consulting engineer for the Dnieper project. The magnitude of the job can, in part, be realized when it is known that the scheme in its entirety will involve an estimated outlay of $70,000,000. Before it is an accomplished fact, rock drills and compressed air will have much to do on the project.

ARE SALMON DESERTING OUR PACIFIC WATERS?

SALMON packed in Pacific Coast canneries is marketed the world over, and annually enjoyed by many millions of people. But this season's pack will probably prove to be not more than 20 per cent. of that of normal years. With good reason, canneries on the Pacific Coast are worried; and, incidentally, they are wondering what has lured this appetizing fish from its accustomed breeding grounds.

The seriousness of the present situation is twofold; first, a large established industry is face to face with a monetary problem of great moment and, next, people accustomed to count upon canned salmon as a part of their dietary will have to be content with a much reduced allowance or, perhaps, go without this toothsome foodstuff that is so full of body-building proteids.

The habits of the salmon have been the subject of scientific inquiry over a period of years, but no one has yet discovered where the newly hatched salmon spends the time between its infancy and those final days of its maturity when it returns to the spawning grounds to die. In a general way, it is known that the salmon, after being hatched out in fresh water, takes to the sea and disappears, and does not come back to those waters until it journeys there to end its mortal cycle.

Billions of salmon fry have been placed in the ocean from government- and state-owned hatcheries in an attempt to offset depletion due to the increasing output of the canneries; investigation has disclosed the periodicity of the

return to the coast of certain species of the salmon; and the salmon-canning business has grown bigger and bigger in the course of 40 years. But always behind these efforts and the knowledge gained by persistent inquiry, the salmon has pretty much gone its own mysterious way.

Something of the same sort happened in the North Atlantic years ago when the tilefish vanished from its feeding grounds after vast quantities of them were found floating dead upon the surface of the formerly productive fishing grounds. Speculation was long rife as to the cause of that catastrophe; and years passed before the tilefish returned. That incident served to show that there are oceanic disturbances that have a destructive effect upon marine life, and that a considerable period is sometimes needful to bring about readjustment or reëstablishment of previous conditions. Let us hope that no such disaster has befallen the salmon of our Pacific waters.

MILLIONS OF YEARS AGO HE ROAMED HERE

THE Black Hills of South Dakota, besides providing a temporary White House for the nation's Chief Executive and giving forth political news of the first magnitude, have recently reminded us that humankind on this continent are newcomers having little regard for those denizens that once roamed over this land when many of our geological monuments had not risen from the depths of the sea or above the plane of the horizon.

A few weeks ago, students of the State College of Mines—under the guidance of its director, C. C. O'Hara—were doing field work in the vicinity of Belle Fourche, and while so engaged those young men uncovered the skull of a *triceratops,* one of the members of the diversified dinosaur family.

As most of us know, the *triceratops* was so named because he was provided with three horns—presumably, defensive weapons, as he is reputed to have been a strict vegetarian and therefore not impelled to kill other creatures in order to round out his dietary. If the pictures painted by gentry specializing in comparative anatomy are reliable portraits of the different kinds of dinosauria, it is our belief that the *triceratops* was ugly enough to keep others at a distance without the addition of horns. But, setting aside this question of relative homeliness, we do think that a creature that had been buried 200,000,000 years had every right to remain undisturbed in the solitude of his grave. We say this even though the skull of that particular *triceratops* was six feet long and four feet wide; and he probably measured 31 feet in length from the tip of his nose to the end of his tail and weighed in the neighborhood of 1,200 pounds when he wandered untrammeled in his pristine pride.

The only comforting thing about this uncovering of the remote past is that we Americans can now point convincingly to a vital background, if not a social one, in which flesh and blood assumed dignified proportions here eons and eons ago.

METHODS OF THE CHEMISTS OF THE UNITED STATES STEEL CORPORATION FOR THE SAMPLING AND ANALYSIS OF GASES. A book of 187 pages, published by the Carnegie Steel Company Bureau of Instruction, Pittsburgh, Pa. Price, $2.00.

THIS book is the result of more than two years' work of a special committee composed of chief chemists of the subsidiary companies of the United States Steel Corporation. The work is comprehensive in its scope; and should prove of great value to anyone having to do with the sampling and the analysis of gases. In addition to describing methods of analysis, the committee has included a great deal of additional information.

SALESMEN IN MARKETING STRATEGY, by Leverett S. Lyon. Professor of Economics. An illustrated work of 422 pages, published by The Macmillan Company, New York City. Price, $4.50.

MARKETING strategy means, of course, the best or skillful use of those mediums by which contacts are established with the buyer or the ultimate consumer, as the case may be. In short, the purpose of this admirable volume, written in a masterly way, is to cut out lost motion and to make the salesman as effective as possible. To this end, there must be a well-planned marketing program; then a proper valuation of the instrumentalities available; and, finally, the use of the program and the instrumentalities in a manner that will assure prompt and compensating results. Here is where strategy counts. Professor Lyon has produced a book that deserves careful reading; and it should serve as a guide for both student salesmen and responsible executives.

GRAPHIC THERMODYNAMICS, by W. S. Huntington. An illustrated work of 205 pages, published by D. C. Heath & Company, New York City. Price, $2.80.

THIS book is intended to offer a graphical method for the analysis of problems involving the heat equivalent of mechanical energy, particularly those relating to the compression and the expansion of air, gases, and vapors.

As explained by the author: "The graphical method permits one to scale from a diagram the heat equivalent of the work done in the cylinder of a compressor or an engine. The heat-work diagram is simple and easily constructed, requiring only the use of pencil, scale and straight-edge, and reference to the charts contained herein or others of like character. The results obtained agree closely with those obtained by use of the well-known indicator diagram; the latter requires careful computation of the area of an irregular figure, whereas the heat-work diagram only requires the scaling of the length of a straight line."

This book should be of value to persons engaged in work that concerns the compression of gases and vapors.

PROFESSIONAL AND BUSINESS ETHICS, by Carl F. Taeusch, Associate Professor of Philosophy, State University of Iowa. This is a work of 370 pages, published by Henry Holt & Company, New York City. Price, $3.00.

THE author believes that the philosopher will find lots of practical applications for his talents if he will keep his head below the clouds and his feet firmly in contact with the earth; and he points out that most of the first-rate philosophers were mechanics, merchants, officials, scientists, and educators whose theories were largely derived from their practical pursuits.

He tells us: "The world is in need of two types of men that it does not have in great abundance: those who are experts in technique, who contribute the ninety-five per cent. of perspiration necessary to carry on well the world's work, and the inspired five per cent. who are possessed of broad enough vision to see what there is to do. It is the latter who anticipate most of the possibilities and troubles of humanity, and in this group the philosopher should be found. And the philosopher has functioned in the past, and can still best contribute his share by directing human efforts through the channels that a useful memory and a far-reaching imagination alone can discover or construct."

With philosophers to guide us, professional and business ethics will be duly fostered.

MARVELS OF MODERN MECHANICS, by Harold T. Wilkins. An illustrated work of 280 pages, published by E. P. Dutton & Company, New York City. Price, $3.00.

THIS book might properly be called a summary of modern accomplishments in the laboratory, in various fields of science, and in the broad realm of engineering. The topics dealt with range all the way from the conquest of the atom to the marvels of modern excavation. There is a chapter on the strongrooms of the sea bed where treasures of many sorts have lain and still lie; and there is, of course, a chapter devoted to the things already done as well as the things that may yet be done in aeronautics. This book will appeal strongly to the imaginative mind and even arouse a far less perceptive mind. In short, it is decidedly entertaining.

Chrome-Nickel Steel in Special Trackwork is the title of a bulletin issued by The International Nickel Company, New York City. This should be of interest to railway engineers.

A Bit of History in the Oxyacetylene Industry is the title of a folder that can be had free, upon request, from the Air Reduction Sales Company, New York City.

Canada and the Twentieth Century is the title of a copiously illustrated brochure published by The Royal Bank of Canada, Montreal. This is an entertaining and authoritative review of Canadian progress and of the opportunities offered in that country of vast natural resources.